An investigation
into the Organisation and management
OF
Science Laboratories in Higher Secondary Schools

A dissertation

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The Faculty of Education,
Vikram University, Ujjain

In Partial fulfilment
of the requirements for the degree
Master of education

Under the guidance of
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By
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PREFACE.

This is an Age of Science and there is a great demand for the Science Education in all the countries of the World. In India also, a majority of the students join the Science Courses at Higher Secondary stage. Unfortunately, very few students continue their studies in the Higher Courses of Science. After completing the Higher Secondary Education, a large number of students develop a fear and dislike for Science. They begin to think that Science is a very difficult subject and, therefore, they change their Optional subject at the Degree stage. Thus, very few students go for the Higher Studies in the Science Courses, with the result that India produces very few prominent Scientists.

'Why the Teaching of Science is not so effective and fruitful in India', is a serious problem for all who are interested in the problem of Education in India. What are the causes for this poor e production of the Scientists in India ? The most important and prominent cause is the ill-equipped Science Laboratories in the Higher Secondary Schools. Our students do not unfortunately get the proper and sufficient opportunities for their practical work in these un-planned and neglected laboratories. Thus, their preliminary concepts are not clear and Science, therefore, becomes a difficult subject naturally for them, for their Higher studeies. According to my humble views, only the well-equipped and properly managed Science Laboratories can produce interest for the Science Courses amongst the student-world.

For the last fourteen years, I have been working, as a Science

teacher, in the Secondary Schools, and hence, I think, I have gained much insight in the Planning and Management of these Laboratories, which are very dear and near to me. For this special reason I preferred to make a thorough study of these Laboratories for my Dissertation work for M.Ed. Examination with the following aims and views :-

(1). To bring to light the poor standard of these Science Laboratories.

(2). To find the economic ways of Planning New Laboratories for the Higher Secondary Schools.

(3). To find economical ways for the organisation and management of these laboratories.

(4). To propose a minimum standard for these laboratories.

Every year, our Madhya Pradesh Government is increasing the number of Higher Secondary Schools with Science subject in the State. But unfortunately, there is no one to care for the minimum standard and requirements of these laboratories. Really speaking, poor laboratories are responsible for creating a dislike for Science subjects among the students. For an effective and fruitful teaching of Science, a well-equipped Science laboratory is the most important condition, to be fulfilled by every Higher Secondary School. More attention should be given to the standard of these laboratories than towards the starting of New Higher Secondary Schools.

More work has been done in this field in the advanced countries, but in India much is yet to be done. I have made an attempt to investigate these Science laboratories and for this work I had to seek the co-operation of many persons.

I must first acknowledge with great reverence my deep feeling of gratitude to my worthy Guide Dr. T.B. Naik, M.A., Ph.D., F.R.A.I., Principal, P.G.B.T. College, Ujjain, (M.P.), who inspired, enlightened and guided me throughout the fulfilment of this Investigation work.

I also take the opportunity of acknowledging my sense of gratitude to the Principals and Science Lecturers of the Higher Secondary Schools who gave me full co-operation in the investigation of Science Laboratories.

I specially thank Mr. M.B. Lalge, M.A., L.T., Principal, Maharajwada Higher Secondary School, Ujjain, (M.P.), who provided me every type of facility in his Institution for my Investigation work.

In the end, I acknowledge my sincere thanks to my colleague and friend Shri M.D. Sharma, for his valuable help and suggestions given for my Dissertation work.

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12th March, 1962.

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First Chapter

CHAPTER. I.

INTRODUCTION.

OUTLINES -

(I). Statement of the Problem.

(II). Need of the Study.

(III). Aims of Study.

(IV). Delimitation.

(V). Methods and Techniques.

(VI). Plan of Attack.

(VII). Difficulties experienced.

CHAPTER I.

INTRODUCTION.

(I). Statement of the Problem -

In this Century of Science, the teaching of Science should be given a dominant place. The progress of any country is judged by its progress in Science. It is only with the progress in Science, that a country can keep up in the race with the more advanced countries of the world. Thus teaching of Science in a country should be given top priority.

Since the Independence, the progress of Science has been accelerated in India also. India is paying more attention toward Science teaching. More facilities are being provided for the study of Science in the Degree Colleges and in the Research Institutions. But Science laboratories are miserably poor at Higher Secondary level. The conditions of these Science laboratories are studied by the Secondary Education Commission of 1952. This Commission writes,

> 'In some of the schools we visited, it was quite clear that the laboratories were hardly ever used, except as store-houses for odds and ends; theoretical instruction in such important subjects as Physics and Chemistry was given in the class room. It is obvious that to teach Physics without instruments, Chemistry without the rudiments of a laboratory would be giving a too theoretical instruction without utilising the many valuable aids, but this is what is exactly happening in certain schools.' [1]

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1. Report of the Secondary Education Commission, p. 208.

The problem, therefore, is how the teaching of Science could be made more effective. This requires spacious and well-equipped Science laboratories for the Higher Secondary Schools. It will be a welcome step, if workshop, Science museum, aquarium, botanical garden, Science library etc., are also attached with the Science laboratories.

For the last fourteen years, I have been working as a Science Teacher in the High Schools and Higher Secondary Schools. During this long interval I have been facing many problems pertaining to Science laboratories which are in shockingly poor condition at present. Most of them are very poorly equipped, even for the elementary demonstration and practical work.

I have met many Science Teachers complaining about the poor standard of these laboratories. I have also seen a number of students talking about the ill-equipped laboratories in our Institutions. In short, all the Principals, Science Teachers and Science students are not satisfied with the present Science laboratories of the High Schools and Higher Secondary Schools. All feel that something must be done to improve the standard of these laboratories in the interest of the country and in the interest of Science teaching. Hence, when I got this opportunity of selecting some topic for my Dissertation work, required for M.Ed. courses, I took the Investigation work of these Science Laboratories. My Topic for Dissertation is -

"An Investigation into the Organisation and Management of Science Laboratories in Higher Secondary Schools."

(II).

(II). Need of Study -

It was natural for me to select this problem of Science laboratories for my Dissertation, as I am more concerned with these laboratories. The Organisation and Management of Science laboratories is the most difficult task of a Science teacher. He has to plan a new laboratory or re-organise the old one. He has to look after the apparatus and chemicals. He has to organise the practical work and moreover he has also to advise about the purchases for these laboratories. These matters require special preparation on the part of a Science teacher.

Since 1958, the High Schools in Madhya Pradesh are being gradually converted into the Higher Secondary Schools. In the old High Schools, practical work in Science was neglected as examination in practical work was not taken by the Board of Secondary Education. Now the condition is much changed as practical examination in Science is made compulsory for every student. Practical examination carries equal importance as the Theory examination. 50 marks out of 150 are assigned for the practical examination for each subject: Physics, Chemistry or Biology. Hence now practical work in the Higher Secondary classes cannot be overlooked. For practical work we require well-equipped Science laboratories. This requires good planning on the part of the Science teachers.

Only theoretical teaching of Science cannot develop the Scientific habits among the students. Only the properly organised practical work can give an intelligent understanding of the Scientific principles. With the help of Experimentation, the students can learn

the laboratory technique and develop the habits of careful and accurate observative and methodical thinking. Thus the practical work in the Science laboratories can inspire ambition in them to explore broader and higher fields of the Scientific knowledge and prepare them for making their creative contribution to the Society.

For the proper Practical work, well-equipped and properly managed Science laboratories are required. The detailed knowledge necessary for the organisation and management of Science laboratories usually takes several years or is picked up at the cost of many failures. The time and effort devoted to these matters is a serious taxation and botheration on the Science teacher's energy and hence the study for finding economical and systematic ways for these purposes should be warmly welcomed.

(III). Aims of Study -

This Investigation work of Science laboratories has been undertaken with the following aims :-

(1). To study the existing condition of the Science laboratories in the Higher Secondary Schools of Madhya Pradesh.

(2). To find out the difficulties of the Science teachers in maintaining these Science laboratories.

(3). To solve the difficulties of the Science students concerning these laboratories.

(4). To find out the economical ways of raising the standard of these Science laboratories in the Higher Secondary Schools.

(5). To bring to light the defects of these Science laboratories in

the Higher Secondary Schools.

(6). To make suggestions for the improvement of these laboratories.

(7). To decide a minimum standard for these Science laboratories necessary for the recognition from the Board of Higher Secondary Education.

(IV). Delimitation -

The study was confined to the Science laboratories of the Higher Secondary Schools of Madhya Bharat Region only, due to the shortage of time. All the types of laboratories in the Higher Secondary Schools are studied i.e., Physics laboratory, Chemistry laboratory and Biology laboratory. For this Investigation work, I have collected the data of the Higher Secondary Schools of the cities as well as of the districts also.

(V). Method and Techniques -

I have used a descriptive method for this study. In this study, I have tried to bring to light the existing condition of these Science laboratories and I have found the possible ways to improve these defects. In order to investigate the existing conditions of these laboratories, the following techniques have been used to collect the necessary data :-

(1). Questionnaires Part 'A' were circulated to the Science Lecturers and Teachers to find their difficulties about the Science laboratories. I have also collected the views of the experienced Science teachers for improving the present poor standard of these laboratories.

(2). Questionnaires Part 'B' were given to the Science students of XI class, with a view to find their difficulties and problems about the practical work in these laboratories.

(3). To find the actual condition of these laboratories, I visited 20 laboratories of the different Higher Secondary Schools. A list of these Institutions is given at the end in Appendix 'B'.

(4). My main aim, in this Investigation work, was to find ways to raise the present poor standard of these laboratories. For this purpose a contact with the experienced Science Teachers and Principals proved very useful. I took Interviews with the Principals and the experienced Science teachers. A list of these persons is given in Appendix 'A'. These persons gave many valuable suggestions for improving the standard of these Science laboratories.

(5). It was very necessary for this Investigation work to have some idea about the work done by other persons in this field. Hence, I have had to read some Standard Books for the Organisation and Management of the Science laboratories. I also consulted several Magazines and Periodicals for knowing the latest methods of laboratory organisation and management. The list of these books and magazines is given in the Bibliography.

~~(6)~~.

(VI). Plan of Attack -

My interest and experience were the main sources in the location of this problem. Two questionnaires were prepared to find the existing condition of the Science laboratories in the Higher Secondary Schools.

Questionnaires Part 'A' was meant for the Science Teachers and Questionnaires Part 'B' was for the Science students of XI class. Questionnaires Part 'A' consisted of questions on Laboratory fittings, furnitures, time devoted for the practical work, number of laboratory assistants and peons. Questions were asked to find the load of periods on the Science teachers and to find the recurring grant for these laboratories. Scheme for the laboratory purchases was also discussed in it. Suggestions from the Science teachers were also invited to remove the existing defects. 150 questionnaires were sent to the different Institutions and 70 answers were received from them.

Questionnaires Part 'B' were circulated among the Science students of XI class of different Institutions. This questionnaire covered questions to find the real condition of the practical work done in the Higher Secondary Schools. I collected the data from 100 students of 20 different Institutions.

My main aim was to find ways to improve the existing poor standard of these Science laboratories. Hence I visited 20 Science laboratories of all types. This gave me good idea about the Organisation and Maintenance of the Science laboratories. At the same time, Interviews with the Principals and experienced Science teachers were arranged to discuss the problems of these laboratories.

Ideal laboratories of other countries were studied with the help of standard books, the list of which is given in the Bibliography. A study of these books helped me a lot, in finding the solution of many difficult problems of these Science laboratories.

In Chapter II -

I have taken the problem of Planning new Science laboratories for a Higher Secondary School.

Chapter III -

deals with the Problem of Organisation and Management of these laboratories.

In Chapter IV -

I have taken the problems of discipline, accident, economy, repairs of apparatus. Here I have also taken the problem of Grants to these laboratories. Scheme for purchasing apparatus and chemicals is also discussed in this chapter.

Chapter V -

deals with the important co-curricular activities of these laboratories which is a necessary aspect of these laboratories in the modern days.

In Chapter VI -

I have analysed the data collected by me. This chapter also gives Conclusions and Suggestions. A minimum standard for these laboratories is decided with the Guidance of the experienced Science teachers. In this chapter, I have also found the cost for the different types of laboratories for the Higher Secondary Schools.

In Chapter VII -

I have taken the problems of the Science Curriculum, Methods for teaching of Science and teaching aids.

Difficulties experienced -

I had to face much difficulty in getting the responses to the questionnaires Part 'A' from the Science teachers. In my first attempt, I could get responses from the 20 teachers only. After a second reminder, I could get 50 responses more. Thus I could collect only 70 questionnaires duly filled in.

Science students have shown great enthusiasm about their questionnaires. They were found more interested in this Investigation work because they were very anxious to have better-equipped laboratories for their practical work.

I am fully satisfied with the cooperation given by those persons whom I interviewed. They gave me very useful suggestions ~~to me~~ about these laboratories.

Second Chapter

CHAPTER II.

PLANNING OF SCIENCE LABORATORIES IN HIGHER SECONDARY SCHOOLS.

Outlines -

(1). Existing Condition of the Science Laboratories in the Higher Secondary Schools in Madhya Pradesh.

(2). Causes for the poor standard of these laboratories.

(3). Necessity for the separate Science Block.

(4). Different Science Laboratories, their fittings and furniture.

CHAPTER II.

PLANNING OF SCIENCE LABORATORIES IN HIGHER SECONDARY SCHOOLS -

(I). Existing Condition of Science Laboratories in Higher Secondary Schools of Madhya Pradesh -

Answers received in reply to the questionnaires served to Science teachers and Science students for the Investigation work gave me a clear picture of the poor standard of these Science laboratories in the Higher Secondary Schools of Madhya Pradesh. Only 41 % Institutions have separate laboratories for Physics, Chemistry and Biology. While according to the New Higher Secondary Scheme, these separate laboratories are necessary to complete the practical course prescribed for these subjects. 59 % Institutions have one common laboratory for all the three subjects. How is it possible to arrange the experiments in one room for Physics, Chemistry and Biology ? This gives an idea about the practical work that is being done in these Institutions. I have received informations that some Institutions do not have Science laboratories, they have no proper equipment and still they have Science classes.

Only 10 % Institutions have dark rooms which is very essential for certain Optical Experiments in Physics. Only 39 % Institutions have water tap arrangement in their laboratories. This causes great inconvenience for the practical work in Chemistry laboratory. Many Science teachers have informed that they have no proper and sufficient practical tables for their students. They have no place to store the apparatus and chemicals. I have visited twenty laboratories personally and found

that 15 laboratories do not have the necessary equipment to complete the practical work prescribed for these subjects by the Board of Secondary Education.

Biology laboratories produce even worse picture before us. 90 % Biology laboratories have no froggery. Most of them have no student microscopes. They have no Botanical Garden and the students have to depend on others for these things.

Condition of the Science staff is not satisfactory in these laboratories. Number of the Science students is increasing every year. Generally they have only one laboratory assistant for all the three departments. How is it possible for one person to manage all the three Science laboratories ? Thus Science laboratories are not properly maintained. 11 % Institutions have reported that they have no laboratory assistants at all. Generally only one peon is given for all the three laboratories. Imagine, how these laboratories can be managed without laboratory assistants and peons. On the contrary, each laboratory must have one full-time laboratory assistant and one peon. Even the number of Science Lecturers is not sufficient and they are over-burdened with periods and other sorts of work. All these result in lowering the standard of Science teaching which is very harmful in this Age of Science. Our students are expected to compete with other countries in the Progress of Science and they are, unfortunately, not getting proper facilities, for their preparation for this competition of the Scientific Progress.

Reports of the Science students produce even poorer picture before our eyes. They say, that they do not get sufficient apparatus for

their practical work. Many students have reported that the apparatus supplied to them are very old, defective and out of order. Thus they do not get correct result of their experiments. They say that there is no sufficient space to stand in the laboratories, no water for washing test tubes and no sufficient time to complete the experiments. 99 % students reported that they do not get a chance to do their practical work in IX class, although they are expected to complete their prescribed practical work in this class also.

When these laboratories cannot provide the necessary apparatus and chemicals, what can be thought of other facilities as Science Club, Workshop, Science Library, Science Museum etc. ? These are very necessary for the creative work of the students and for creating interest for Science. Only 6 % Institutions have Workshop, 10 % have Science Libraries, and 51 % have Science Clubs. In this Changing World of Education, these activities cannot be neglected and they are necessary part of the curriculum.

Secondary Education Commission has written,

> "We understand that, in some Universities, definite rules have been framed in this behalf and a list of essential equipment needed for each subject and for a certain number of students to be taught in such subjects has been drawn up. It is a condition of affiliation that the minimum equipment as set down should be made available before affiliation can be granted to the College." 1

This principle should also be observed for the Higher Secondary Schools.

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1. Report of the Secondary Education Commission 1952-53. p. 208.

Looking into these conditions, many Science teachers have suggested that some minimum standard should be decided for the recognition of the Institution for the Science Group by the Board of Higher Secondary Education. At present all the Higher Secondary Schools are allowed to start the Science Group whether they have proper laboratories and staff or not. In the interest of the students and of the country also this procedure should no longer continue. It must be made compulsory that before starting the Science teaching, every Institution, must get recognition from the Board of Higher Secondary Education. Before giving the Recognition, a Committee should inspect these laboratories and this Inspection work should not be formal only.

(II). Causes for the poor standard of these laboratories -

It is very necessary to know the causes of the existing poor standard of these Science laboratories for my Investigation work. I have consulted Principals and experienced Science Teachers for this and I have come to know the following causes for the poor laboratories in the Higher Secondary Schools :-

(1). The old High Schools are being converted into the Higher Secondary Schools. Now these High Schools have only one laboratory with very small number of apparatus for all the three subjects. Students of the High School Classes do not have the Practical Examination, in these subjects. Thus, well-equipped laboratories are not provided by these High Schools. Students are not allowed to do their practical work in these subjects.

But, according to the new Higher Secondary Scheme, the

conditions are changed. Now the Practical Examination in these subjects is made compulsory for the students. Out of 150 marks in each Science subject, 50 marks are assigned for the practical work. Thus, it is compulsory for the Science students to complete their practical work prescribed by the Board. Now the practical work cannot be neglected. All these changes demand that the standard of Science laboratories in the Higher Secondary Schools should be raised.

(2). The Grant given for starting these laboratories is not sufficient. They are expected to start all the three laboratories with a small sum of Rs. 5,000/- which is next to impossible during these days.

(3). No proper Planning is done for these laboratories due to the new and inexperienced Science Teachers. They are fresh Graduates or Post-Graduates from the Colleges and they are not even trained for the Laboratory work. If they purchase apparatus, they do so, without any Plan for the laboratory and thus the difficulties about these laboratories are increasing day by day.

(4). The Laboratory Assistants are only Matriculates and they have no idea about the organising and managing of these laboratories. Any how, they pull on, with their work at the cost of efficiency.

(5). All the students,irrespective of their poor results of the previous examinations, are allowed to offer the Science subject, in the Higher Secondary classes. Thus, number of Science students is increasing day by day and higher standard of proper facilities for the practical work cannot be provided within limited means.

(6). Generally, the Head of the Institution, is a Non-Science man, and there is a lack of cooperation between him and the Science Staff. This naturally very much hinders the progress of the Science teaching.

(7). Science Teachers are over-burdened and they do not get sufficient time to look after these laboratories.

(8). These laboratories are never inspected by the proper authorities or by the Inspectors from the Board of Higher Secondary Education. Thus, they have no proper checks and the Science Teachers are free to neglect their practical work.

In the following paragraphs and in the chapters to follow, I would be trying to find out the proper ways of improving these Science laboratories in the light of the advice, given by the Principals, and experienced Science Teachers.

(III). Necessity for the separate Science Block -

100 percent Science Teachers have suggested that every Institution should have separate laboratory for Physics, Chemistry and Biology. Thus three laboratories are required in every Institution. Moreover, Dark-room, Store-room and Preparation-room are also required for these laboratories. Hence, it is convenient to have a separate Science Block having all the above rooms. In the old buildings of the Higher Secondary Schools, three adjoining rooms may be selected for this purpose. In the new buildings to be constructed a proper arrangement of the separate Science Block should be kept in view.

I am giving a Model of such a Science Block in Figure No. 1.

SCIENCE BLOCK

SCALE :- 0·1 INCH = 2 Ft.

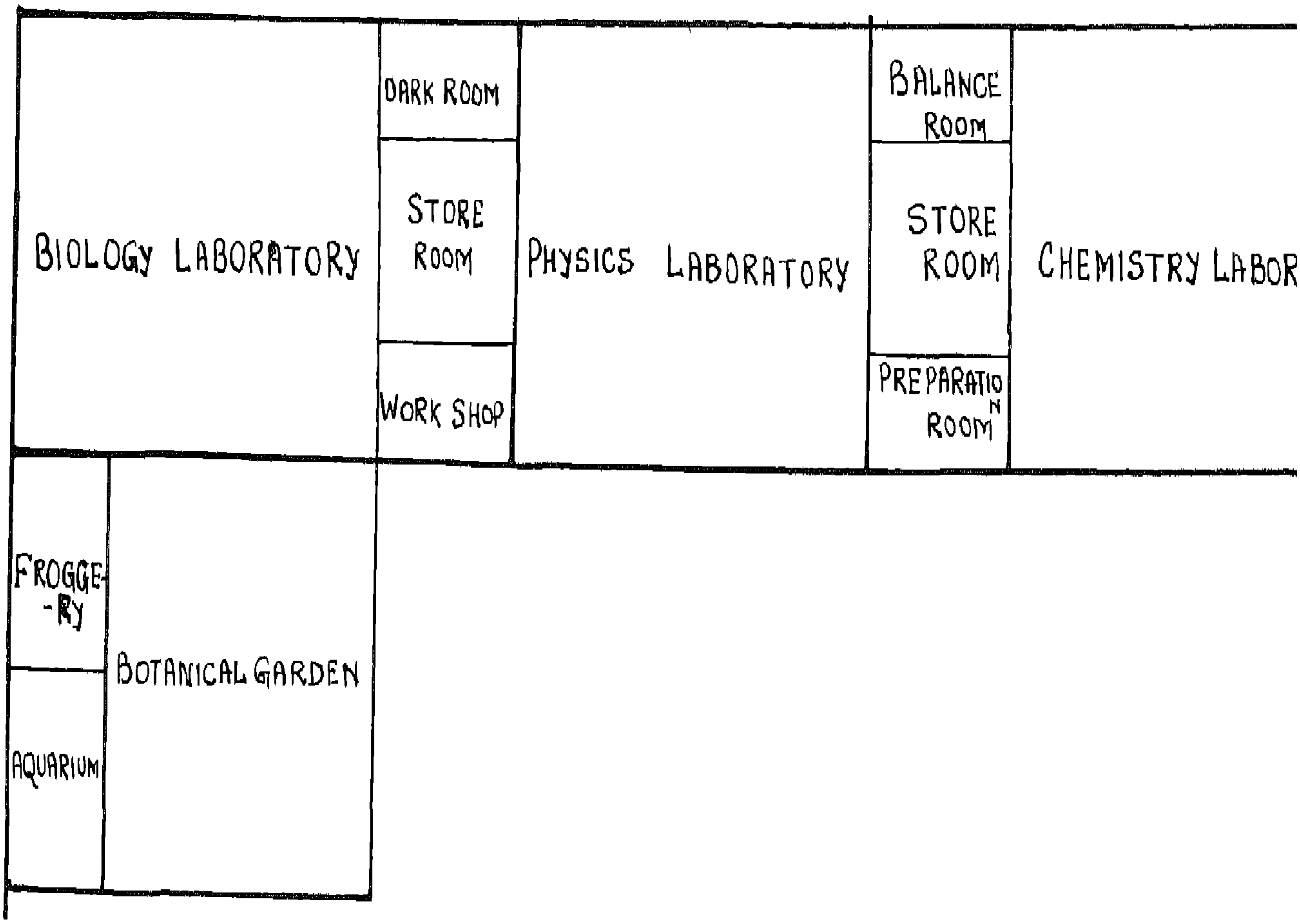

FIG. NO. 1

This Science Block has been constructed with a view that 36 students can do their Practical work, in each laboratory, at a time.

The floor area required for 36 students is 1152 square feet and hence the convenient size of each laboratory may be 40 feet long and 30 feet broad.

Figure No. 1 shows the positions of all the Science laboratories, their Store rooms, Preparation rooms, Froggery, Botanical Garden etc., in a separate Science Block.

This Scheme shows how convenient is it to have all the laboratories and Store rooms in one separate Science Block for every Higher Secondary School. This Scheme is suggested only for the new construction of buildings. In the old buildings, these rooms can be selected at one corner of the School building. This Scheme of the separate Science Block is useful for the Science subjects as well as for the other working of the Institution. Thus, Science students get a calm and quiet atmosphere for their practical work, having no disturbance from the other classes. At the same time, other classes are not disturbed by the harmful gases of the Chemistry laboratory. Positions of the dark rooms, store room, preparation room, staff room etc., are very conveniently arranged in this Scheme.

Now, I shall discuss each laboratory, its fittings and the necessary furniture for it.

(IV). Different Science Laboratories, their fittings and furniture -

Position and Area of Chemistry Laboratory -

Figure No. 2 shows the arrangement and fittings of Chemistry laboratory. The position of this laboratory needs some special considera-

CHEMISTRY LABORATORY

Scale :— 0 3 INCH = 2 Ft.

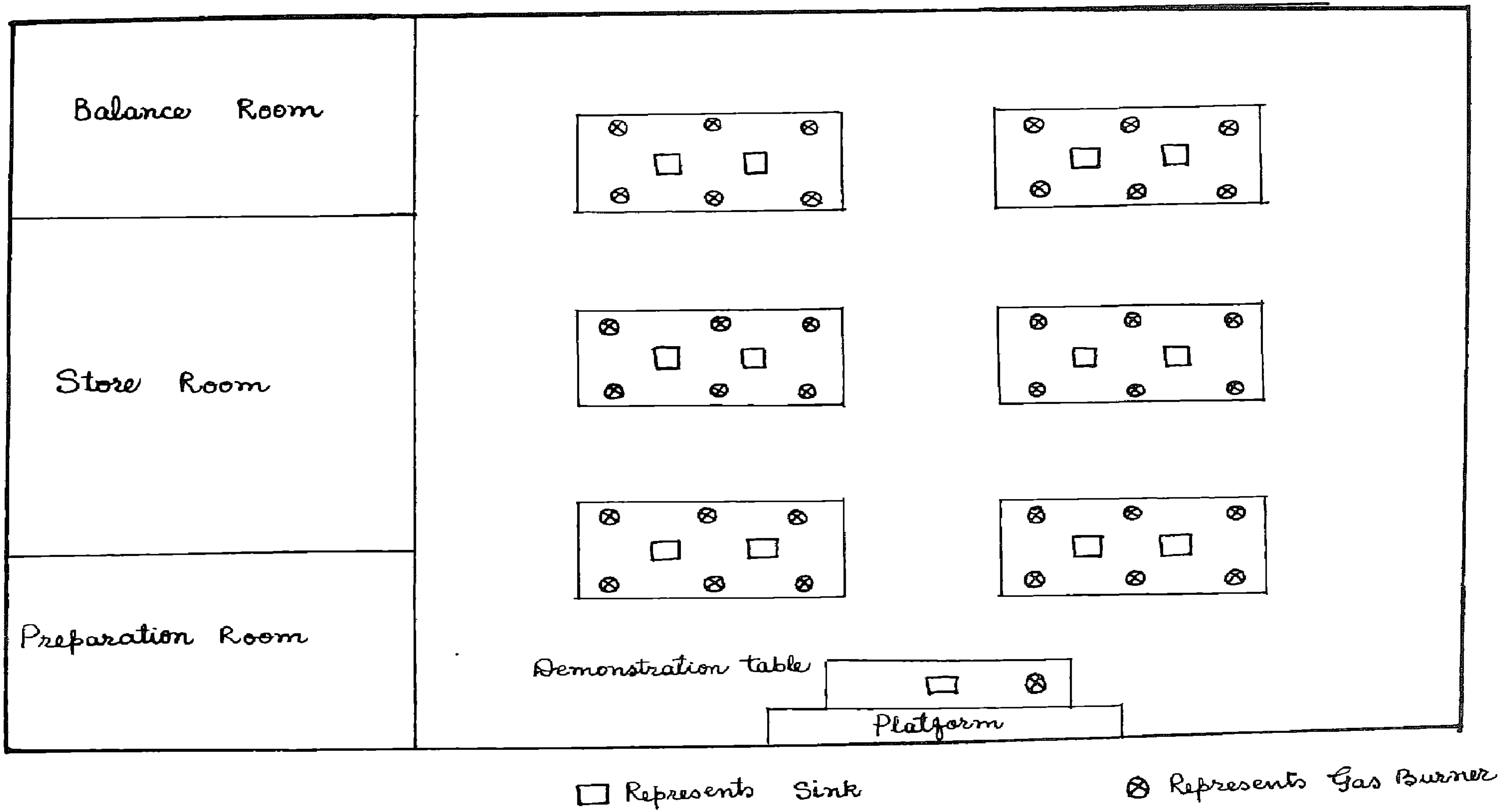

FIG. No. 2

tion due to its obnoxious fumes produced during the practical work. Hence it should be situated at one corner of the Science Block in such a position that these harmful fumes will be carried away from and not into the School. This arrangement makes it possible to save other classes from these harmful fumes of the Chemistry laboratory. 'The minimum space per student is 30 square feet.'[1] Thus the space required for 36 students should be 1080 square feet. Hence the convenient dimensions of the room may be 40 feet long and 30 feet broad.

Practical Benches and their Fittings -

The dimensions of the Practical Bench may be 12 feet long and 4½ feet wide, with a height of 3 feet. On each bench, 6 students can easily work - three on each side. These double benches are very economical. Each bench should have a shelf running the whole length in the middle position. The shelf must be 12 feet long, 8 inches wide and 2 feet high. Each shelf should be divided into three parts. Reagent bottles should be placed in order in these shelves. Drawers should be fitted in the practical tables. Pipe-clay, triangles, wire gauzes, crucible tongs etc. can be placed in these drawers. The dimensions of each drawer may be 3 feet long, 2 feet wide and 4 inches deep.

Each Practical table should have 6 drawers, three on each side. Beakers, pipettes, burettes and their stands may be placed in cupboards of the Practical tables. One small waste box should be fitted in each table to hold used filter papers and broken test tubes etc. On each Practical bench two sinks should be fixed in the position shown in

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[1] School Laboratory Management by Sutchiffe. p. 4.

Diagram No. 2 by the Symbol 'S'. Two sinks will be sufficient for all the six students - one one bench. The size of these sinks may be 15"x12"x8". Each Practical bench should have 6 Gas Burners for the students. The sinks should be provided with ~~wastes~~ water taps wherever possible. All Reagent bottles should be labelled properly.

Demonstration Bench -

Demonstration Bench in the Chemistry Laboratory is very necessary. The convenient dimensions of this demonstration bench can be 9 feet long, 3 feet wide and 3 feet high. The top should be of 1 inch in thickness. This bench should be placed on a platform about 9 inches high so that the Science teacher can supervise the students during demonstration work. Ample space should be provided in front of the demonstration bench to allow the students to gather round it to see the demonstrated experiments. This bench should be fitted with the cupboards and three drawers. One sink of size 12"x10"x8" should ~~fi~~ be fixed in the position as shown in Diagram No. 2. One Gas burner should also be fitted in this bench. Sinks should be provided with water taps.

Store and Preparation Room -

It is very necessary to have a separate store and preparation room attached to the Chemistry Laboratory as shown in the Diagram No. 2. Generally, at present, Chemicals, Acids, Salts and other apparatus are stored in the Chemistry Laboratory itself. This procedure is very inconvenient and risky. This also produces a gloomy appearance of the laboratory. Much space is occupied by these chemicals and apparatus and moreover, they are not safe there. Chemical balances are also placed in

the laboratory itself. This causes more accidents and breakages in the Chemistry laboratory. These are the present conditions of these laboratories in the Higher Secondary Schools. This should be stopped and separate store and preparation rooms should be provided. Some Institutions do provide these store rooms as I have visited during my Investigation work.

Chemical balances should be placed in this store room so that the balances may be kept free from the harmful fumes and are at a place where there is a little traffice. This store room should have cupboards with sliding glass doorsand fitted with shelves. Reagent bottles, acids and other chemicals can be stored in this room. This room should also have a large sink of 2 feet by 2 feet by 1 foot in size. A rack 6 feet long and 4 inches wide should be arranged in this room for glass tubing and rods. Poisonous and inflammable substances as Phosphorous, Sodium, Cynides etc., should be placed under lock and key.

Keys belonging to the drawers and cupboards should be placed on a Key-board, fixed on the wall of the Store room at a convenient place. This Key board must have a number of hooks and each hook should bear a number corresponding with that on some one key. This arrangement will save time and botheration.

The Chemistry laboratory should always have at least two ways - one in and one out, so that one of them can serve as an emergency exists, in case of fire etc. This laboratory should have electric fittings, if possible.

Physics Laboratory - its fittings and furniture :

Size of Physics Laboratory -

In Figure No. 3 - details of Physics laboratory and its

PHYSICS LABORATORY

SCALE .— 0 3 INCH = 2 Ft.

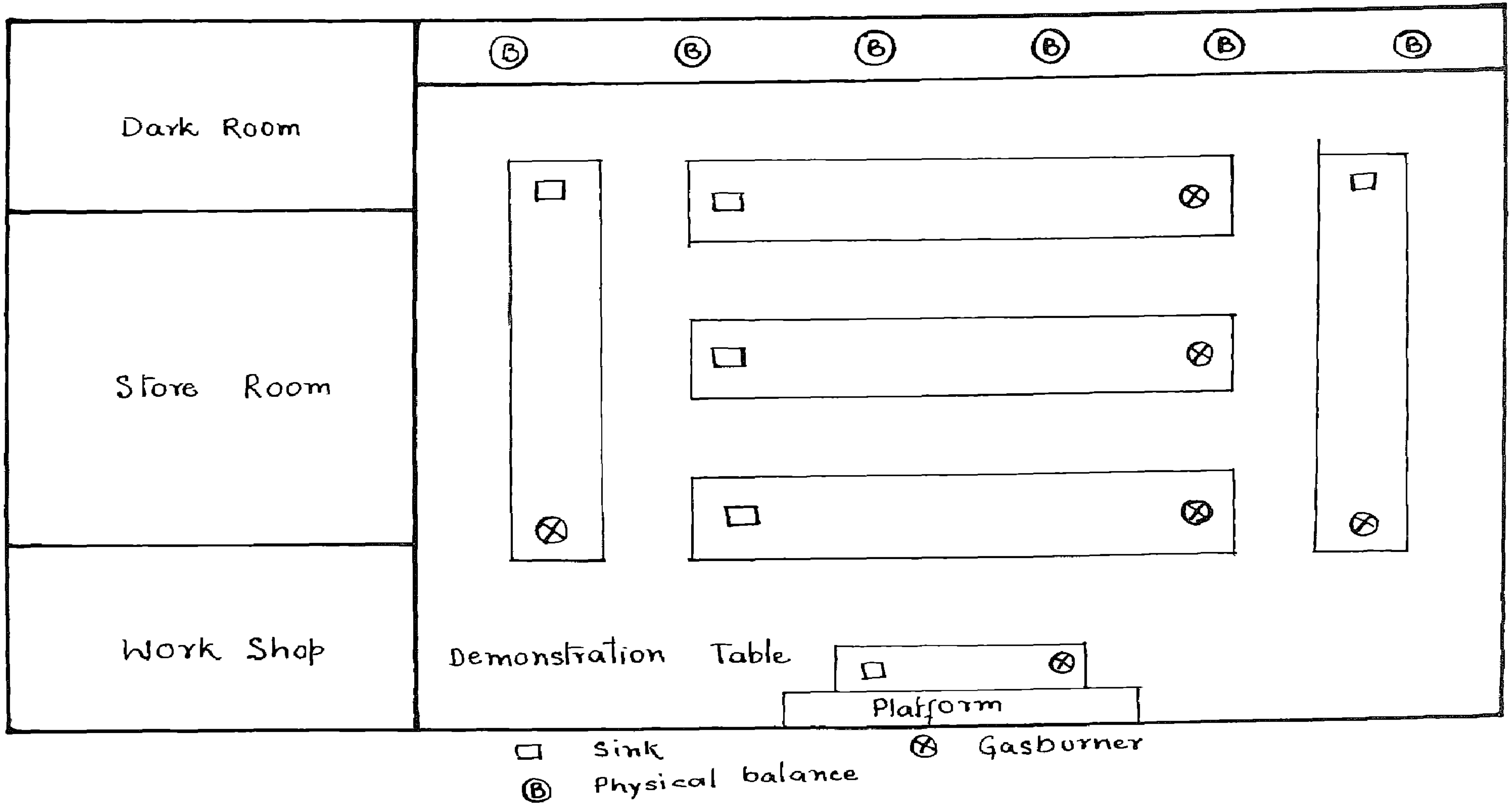

FIG. NO. 3.

furniture are shown. The size of the laboratory room is 40 feet long and 30 feet wide. This space will be sufficient for 36 students. On the left hand side, workshop, store room, dark room and staff rooms are shown attached to the Physics laboratory.

Practical Tables -

In the Physics laboratory, generally, long benches are required for certain experiments as Metre bridge, optical bench, sonometer etc. Hence it is better to have the dimensions of these benches - 20 feet long, 3 feet wide and 3 feet high. Sinks and Gas Burners are not required on each bench as in the case of the Chemistry laboratory. Hence this laboratory should have some common sinks on the wall side as shown in Figure No. 3. Gas burners are also not required on each bench. Hence some common burners should be arranged in this laboratory. Drawers and cupboards are also not required for this laboratory. In short, the Practical benches should be of simple design without shelves, drawers, cupboards etc.

Other Fittings -

Physics laboratory must have electric fittings because it is required for charging the accumulators and for heating water for the Experiments in "Heat". It should have water taps and gas taps but not so many as are required for Chemistry laboratory. Dark room should also have electric fittings and one sink arrangement.

The size and other details of Demonstration Table are same as those of Chemistry laboratory.

Store Room and Workshop -

This room is very necessary to store a large number of different

apparatus in a systematic manner. All those apparatus which are more frequently required should be grouped together at one place for example, scales, cork borers, gas jars, beakers, connecting wires etc.

Other apparatus should be stored in different almirahs. One separate almirah should be given for mechanics, heat, light, sound, magnetism, electrostatics, current electricity. These almirahs should be labelled with a brief indications of its content.

This room should have dust-proof store cupboards. One should be 4 feet long, 1½ feet wide and 2½ feet deep to hold wheat store's bridge, air pump etc.

Physical balances should be kept in glass cases. They should have complete weight boxes.

In workshop, we require side benches - 30 inches wide along the walls of the room. The side benches should be fitted with drawers and cupboards. It should have the necessary tools, drills, files, screw-drivers, hammers, pliers, saw etc.

Biology Laboratory -

This laboratory should be situated so that it is lighted from the north. For this diffused light is most suitable for microscopic work. For this laboratory simple tables, without cupboards and drawers, are required. Dimesions of each single Practical table must be 4 feet long, 3 feet high and 3 feet wide. Only a few sinks and gas burners are required. Some tables should have electric arrangement so that microscope can be used in dull weather also. Places for an oven, a still and an aquarium should be provided. It should have lockers for microscopes.

BIOLOGY LABORATORY

Scale :- 0·3 INCH = 2 Ft.

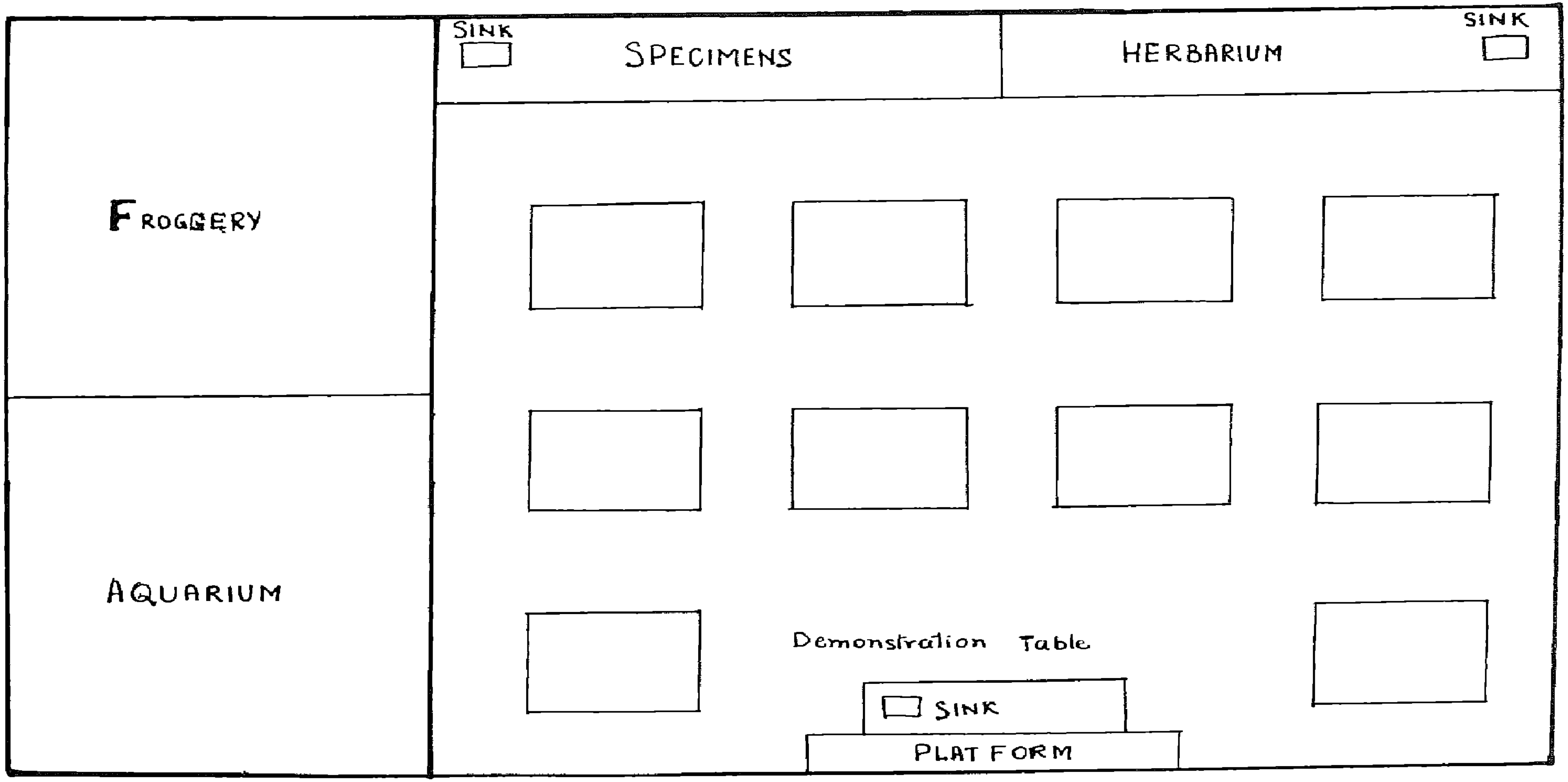

FIG. NO. 4

In addition, there should be a Museum Cupboard and shelves for specimen bottles. There should be arrangement for froggery also. There should be a small Botanical Garden attached to this laboratory. All these details of a Biology Laboratory are shown in Figure No. 4.

Present conditions of the Biology Laboratory is very pitiable in the Higher Secondary Schools of Madhya Pradesh. They have no Froggery and Botanical Garden for the Practical work. Even they do not have ~~sufficient~~ sufficient number of students' microscopes for the Practical work. Students of IX and X Classes do not have the Practical periods. Thus the Practical work is completely neglected. Grant for these laboratories is also very poor.

In the above paragraphs, I have given the Ideal arrangements. However, some adjustment must be made according to the local circumstances. At many places, we do not have electric power and hence the laboratories cannot have the electric fittings. Similarly, many towns have no water supply, hence some temporary arrangement should be made for cleaning purposes. Similarly, only big Higher Secondary Schools can have Gas Plant arrangement. Small Institutions can use stoves and spirit lamps for heating purposes.

If the old furniture is available in the School, a proper use can be be made of them by having shelves for the reagent bottles for the Chemistry Practical tables. But it is very necessary to have a separate laboratory for Physics, Chemistry and Biology, according to the new Syllabus for these subjects. Similarly, three laboratory assistants and three peons are required to maintain these laboratories separately and properly.

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Date [illegible]

Third Chapter

CHAPTER III.

LABORATORY ORGANISATION AND MANAGEMENT -

Outlines -

(I). Duties of Laboratory In-charge, Laboratory Assistant and peons.

(II). Storage of apparatus and chemicals.

(III). Maintenance of Stock Registers.

(IV). How to organise the practical work for the students ?

(V). Daily weather information.

(VI). Decoration of Science laboratories.

CHAPTER III.

LABORATORY ORGANISATION AND MANAGEMENT.

(I). Duties of Laboratory In-charge, Laboratory Assistant and Peons -

During my Investigation work, I found that most of the Institutions have one common laboratory for Physics and Chemistry and one for Biology. Generally a Senior Science hand is made In-charge of the laboratory. But it is a surprising fact that he is not given sufficient free periods to look-after the laboratory work. Thus he takes this work as an extra burden upon himself. Hence it is very important to give facilities to the Laboratory In-charge. The first thing is that there should be a separate In-charge for each laboratory and second important thing is that he should not be given more than 18 teaching periods per week.

Duties of the Laboratory In-charge -

(1). He is responsible for the whole working of the laboratory.

(2). It is he who has to prepare a list of the requirements for the next session, in advance.

(3). He is responsible to purchase the apparatus and chemicals of good quality and at reasonable cost.

(4). He should arrange the Time-table for the Practical work for the students.

(5). He should maintain the record of the experiments performed by the students with the help of their Science Teachers.

(6). He should see that costly apparatus and poisonous substances are kept under the lock, and keys should be with him.

(7). He should see that the laboratory assistant and peon do their work properly.

(8). He should maintain Stock Registers for his laboratory. Entry of new things and writing off perishable and broken things from the Stock Register should be done in time to keep the record upto date.

(9). He should check the stock of the laboratory once a year.

(10). He should see that all the apparatus under his charge are in the proper working order.

Powers of the Laboratory In-charge -

As the Laboratory In-charge is a senior and more responsible ~~a~~ person, he should be given sufficient powers concerning the laboratory. At present they have to depend on the mercy of the Head of the Institution even for the ordinary matters. Education Department should frame some rules for this purpose.

Following Powers are necessary for the In-charge for the proper maintenance of the laboratory -

(1). He should be given full powers to purchase apparatus and chemicals from the Recurring Grant for his laboratory. At present there is much interference from the Principal in this respect and inferior quality of apparatus are purchased.

(2). He should be authorised to write off the perishable articles from his stock. This will help in the maintaining of the Record upto date. At present, broken things are not written off for a number of years from the Stock Register.

(3). He should be authorised to purchase petty local things as soap, match boxes, candle sticks, towels, kerosene oil etc. Hence an amount of Rs. 50/- should be advanced to him for these local purchases.

(4). He should be asked to Plan the Time-table for the practical periods. As he is in touch with the laboratory, he knows the condition better as the number of apparatus available and number of students to be kept in one batch etc.

At present the Time-table is generally framed by a person who is not in the know of the above-mentioned facts and many difficulties arise in the actual working. To avoid all these things, he should be asked to frame the Time-table according to the condition of the laboratory.

In short the interferences in the matters of Science Laboratories should be minimised to make the working easier and better.

Duties of Laboratory Assistant -

Laboratory Assistant should be a man of Science and moreover he should have some training for the laboratory work. He should be a Science Graduate as many Science Teachers have given their suggestions to me.

At present, only Matriculates are working as the Laboratory Assistants. They cannot maintain the apparatus properly. Hence it is very necessary that only the Science Graduates should be appointed on this post. Of course a handsome salary should be given to them.

The duties of a Laboratory Assistant may be classified as below :-

(1). Arranging the apparatus for individual experiments for students.

(2). He should arrange the apparatus for the Demonstrations experiments in advance.

(3). He should repair the ordinary apparatus with the help of the students.

(4). He should see to the maintenance of all fittings as gas taps, water taps, sinks etc.

(5). He should unpack, check and store the new apparatus and chemicals on arrival with the help of the laboratory peon.

(6). During the holidays, he should inspect the gas plant, water taps, etc. He should grease the burettes and gas jars.

(7). He should see that all the apparatus are placed in their proper places.

(8). He should see that the Physical Balances are in the working order.

(9). He should inform the In-charge about the Laboratory requirements in advance.

(10). He should keep a proper record of the apparatus issued to the students.

(11). He should see that the laboratory is properly locked after the school hours.

(12). He should maintain the record of the broken apparatus properly.

Duties of Laboratory Peons -

Each laboratory should have a separate peon. He should work under the guidance of the In-charge and Laboratory Assistant. At present some peon is asked to attend to the laboratory work, only for a few hours. This procedure is hindering the working of laboratory very badly. His duties are given on the next page :

(1). He should clean the floor of the laboratory daily after the school hours.

(2). He should clean the apparatus and test tubes daily.

(3). He should see that sufficient water is stored for the use of the students in advance.

(4). He should help the Laboratory Assistant in arranging the apparatus for experiments.

(5). He should grease the glass stopcocks of burettes.

(II). Storage of apparatus and chemicals -

At present, most of the laboratories have no separate store-room for apparatus and chemicals. Out of twenty laboratories visited by me only five laboratories have separate store rooms and preparation rooms. As the number of almirahs available is not sufficient, the apparatus and chemicals are stored in the haphazard manner. All the almirahs are kept in the laboratory itself and it gives a very bad looknand much inconvenience is caused during the practical work. It causes more breakages and accidents in the laboratory. Moreover, much time is wasted in searching for apparatus and chemicals as they are not stored in a systematic way. In order to avoid all these troubles, the following precautions must be taken while storing the apparatus and chemicals :-

First of all, there must be one separate almirah for the apparatus of general properties, heat, light, sound, magnetism, electricity etc. A list of the apparatus contained by one particular almirah should be pasted on the almirah itself. In the Physics Laboratory, many apparatus as metre bridge, potentiometer, sonometer etc., can be left fitted on the

benches where they will be used. Every similar piece of apparatus should be stored in the same place as beakers, flask, corks, glass tubing etc.

In Chemistry laboratory much time and trouble is saved by arranging the salts and chemicals in the alphabetical order. These things should not be stored at places out of reach, without the use of chairs. This can save serious accidents in the laboratory. Poisonous substances should be kept under the lock and key. Deliquescent, hygroscopic and efflorescent substances should be stored in well-stoppered bottles. Special care should be taken in storing sodium and Phosphorous.

For XI Class, Test tubes, burette, pippete, flasks, beakers etc., should be given to individual students. They should be asked to keep these apparatus under lock and key. This will give a clear account for the breakages of apparatus at the end of the Session. Hence it would facilitate the realisation of fines from the students for breakages. Moreover, it would save us from daily issuing and collecting work for those apparatus. A list of all these apparatus contained in the almirahs or cupboards should be pasted on them. All the bottles of chemicals and salts should be labelled properly.

Broken glassware, and broken apparatus should be stored in one separate wooden box.

Maintenance of Stock Registers -

At present, many laboratories have only one stock register. Chemicals and apparatus are entered in them datewise. Hence it is very difficult to have a clear idea about the balance of chemicals, of salts, whenever desired. This procedure is very defective. ~~Sa~~ Same substance

for example sulphuric acid is recorded at five or six places in the same stock register and one cannot get any idea about the substance in stock.

Hence, it is better to have separate stock registers for the perishable and non-perishable substances. One page must be given to each item. The details of the stock register should be as under :-

(1). Date of receiving the apparatus or chemical.

(2). Name of the Company supplying it.

(3). Bill No.

(4). Cost of the apparatus.

(5). Number or quantity received.

(6). Signature of the Laboratory In-charge.

(7). Number of apparatus broken or quantity of chemicals used up with date.

(8). Balance left.

(9). Date of checking the stock.

(10). Signature of the Laboratory In-charge.

If the record is maintained in the above tabular form, much botheration would be saved, at the time of the stock checking.

Moreover, it is necessary to have one Register for breakages. This must contain information as about the date, name of the apparatus broken, name of the student who broke it, amount realised as a fine, and how this amount is disposed off.etc.

We should also maintain an Issue Register to keep the proper record of the things issued. This would enable us to realise the

apparatus from the concerned person.

If all these Registers are maintained properly and regularly, there would be no danger of missing any apparatus from the Laboratory. Moreover, the Laboratory In-charge would be saved from many botherations.

(IV). How to Organise the Practical Work for the Students -

First of all the batches of the students should be formed according to the space in the laboratory and number of experiments available in the laboratory. In Physics, two students can be placed in the same Group. In Chemistry and Biology laboratory, individual experiment should be given.

Allocation of Experiments -

We can profitably use the University Laboratory Method of allocating different experiments to different pupils, working singly or in pairs. A Rota System should be used. The teacher in-charge of the practical work should maintain this record as given in the Table below. A large sheet of paper should be divided in the horizontal and vertical columns as shown in the given Table. Name of the experiments should be written in the horizontal columns and names of the students should be written in the vertical columns. When an experiment is allotted to a student, the teacher should put a dash in the appropriate space, and when it has been completed he should cross the dash. This Table can give a clear idea of the work done by the students and the experiments that can be allotted to the other students. This Table should be hung on the wall at some proper place. This Table will create much interest and a sense of competition among the student-community to complete the experiments.

Our Table No. 1 on the next page shows all these details clearly.

TABLE NO. 1.

Record of Practical work done by the students of

Class - XI A. **Subject** - Physics. **Year** - 1962-63.

S.No.	Name of students.	Focal length of concave mirror.	Refractive Index of water.	Simple Pendulum.	Young's Modulus.	Verification of Boyle's Law.	Specific heat by Newton's Law of Cooling.	Latent Heat of Steam.	Coefficient of Linear expansion.	Comparison of E.M.F. of two cells.	Verification of Ohm's Law.	Comparison of Magnetic moments.	Lines of force.	Specific gravity by R.D. bottle.
1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11.	12.	13.	14.	15.
1.	Amritlal Vyas.	x			x		x				1			
2.	Balwantsingh Chauhan.		x	x					x			1	x	
3.	Chandrakant Gupta.		x				1		1	x				
4.	Darshansingh.		x					x			x		1	
5.	Damodardas.	x			1					x				x
6.	Fakirchand Jain.			x	x					1			x	
7.	Goverdhanlal.	x						1				x	x	
8.	Hiralal.	1	x		x					x				
9.	Hariprasad.		1			x			x		x			
10.	Indrajeetsingh.			1	x			x				x		
11.	Kanakmal.	x		x		1							x	
12.	Laxminarayan.			x				x		x				1
13.	Manoharlal.	x	x	1			x		x					
14.	Narendra Vyas.		x				x			1		x		
15.	Prakashchandra.	x		x							x			1
16.														
17.														
18.														
19.														

Preparation for the Experiment -

It is better to have a typed copy with each experiment about the Method, Observations to be taken, Calculation and Precautions etc. This will take much time, in the beginning, but it would be a permanent thing for the laboratory. This would give a very helpful guidance to the students and they would not run to the teachers for small thing every moment. Hence the teacher's burden would be much reduced by the following of this procedure.

All the necessary apparatus should be collected on the prescribed Table for the concerned experiment. Students should be asked to check the apparatus and report to the Laboratory Assistant according to the list.

In the end, each student should report to the teacher about their results of the experiments and the teacher should allot the new experiment for the next turn.

I visited twenty laboratories and found that no proper and systematic record is maintained anywhere about the experimental work of the students. Only the Note Books of the student can give some idea about the number of experiments completed by the student. The above precautions and procedure are very necessary for keeping an upto date record about the experimental work of the students. They are also useful at the time of Inspection by the Authorities. They would also give to the students an idea as to how many experiments are yet to be completed. They would also be useful for the Science teachers.

(V). Notice Board for daily weather information -

Informations about the daily weather of the local place are very

essential for all. Students should know about the weather of their local place. This work can be done easily by the Science students as they have proper equipments as maximum - minimum thermometer, barometer, rain gauge etc., in their laboratory.

But it is a surprising fact that no Institution cares to maintain and notify these informations. I have not found this practice in any one of the Institutions that I visited.

One General Notice Board should be prepared for this purpose. Students of XI class should be asked to write the following information on this Notice Board daily by turns. It should have the following details :-

---

1. Maximum temperature. _______. Minimum temperature. _______.
2. Pressure. _______. Time. _______.
3. Humidity in air. __________.
4. Rainfall. _________.
5. Total Rainfall during the year. _____

Some important event concerning Science should also be written on this Notice Board. Cuttings from the Newspapers and Magazines should be pasted on this Board.

This procedure will help in a increasing the General Knowledge of the students. Students will take interest in doing this work and this would produce a very useful activity of the School curriculum.

(VI). Decoration of Science Laboratory -

I found during my visits to the Science Laboratories that some of them were well-decorated. Photos of the Scientists were hung on the walls of the laboratories. I also found Charts of Physics and Chemistry in some of the laboratories. But these Charts were purchased from the market. Very few laboratories have the charts prepared by their students. Science-teaching should make the students to do some creative work themselves. Theoretical work alone, is not sufficient.

I propose that students should be asked to prepare the charts themselves. Worthy and useful charts should be hung in the Science Laboratories. This activity can be encouraged among the students by giving them marks assigned for activities for the examination. Students will learn many important facts in preparing these charts. Thus, hand-prepared charts are more useful than the printed ones.

I have made it compulsory for each Science student of my class, to prepare at least five charts during each Session.

At present, laboratory rooms are also used as store rooms in the Higher Secondary Schools. Hence they produce very ugly picture. It is very necessary to keep the laboratories well-arranged and decorated.

Fourth Chapter

CHAPTER IV.

SOME IMPORTANT PROBLEMS OF SCIENCE LABORATORIES IN HIGHER SECONDARY SCHOOLS.

Outlines -

(1). Discipline in the Laboratory.

(2). Accident in the Laboratory.

(3). Economy in the Laboratory.

(4). Repairs of the Apparatus.

(5). Recurring and Non-Recurring Grants for the Laboratory.

(6). Scheme for purchasing the apparatus and chemicals.

CHAPTER IV.

SOME IMPORTANT PROBLEMS OF SCIENCE LABORATORIES IN HIGHER SECONDARY SCHOOLS.

(I). Discipline in the Laboratory -

It is very essential to maintain the proper discipline in the laboratories, from two points of view. Firstly, it will minimise the laboratory accidents and secondly the students would be able to work better. They would be able to complete their experiments in time and moreover good discipline in the laboratory would help them in getting correct results of their experiments.

After consulting many Senior and experienced Science teachers, I have come to the conclusions that the following Rules should be observed in the Laboratory :-

(1). Students should be asked to stand in a line outside, before entering the laboratory. Then they should be allowed to enter the laboratory one by one. They should be guided by the Science teacher to go to their proper places for their experimental work.

(2). Science teacher should see that all the necessary apparatus are placed on the Practical Bench and that they are in the working order.

(3). Students should not be allowed to borrow apparatus from other students. If they need any apparatus, they should inform the teacher.

(4). Breakages should be reported at once to the Teacher in-charge.

(5). When the Practical periods are over, all apparatus must be cleaned and kept in their places properly.

(6). Water, gas, electricity must not be wasted by the students.

(7). Students should consult their teacher in-charge, when they need some help. They should not talk among themselves.

(8). No student should be allowed to enter the store-room or the preparation room.

(9). Students should not be allowed to leave their seats before completing their experiments.

(10). Students should get sufficient time to complete their experiments.

(11). Any student not obeying these Rules should not be allowed to work in the laboratory.

The above Rules would help in maintaining the proper discipline in the Laboratory during the Practical work. Students would learn good habits and manners also. They would be able to complete more work in the same time, if a proper discipline is maintained in the laboratory.

(II). Accidents in the Laboratory -

During my Investigation work, I cameto know about many accident cases occuring in the laboratory. One teacher informed me that one student was trying to insert a glass tube in the hole of a rubber cork and the tube suddenly broke and his hand was badly injured. Other gentleman reported that one student got his eyes burnt while he was opening the cork of a bottle of strong liquor Ammonia. Phosphorous burns are very common in the laboratories. Explosion of the mixture of Hydrogen gas and air are

also reported by some Science students. Cuts from the glass tubes and tests tubes are also very common accidents. There are also reports from time to time that many students get burns from strong acids due to their carelessness.

Sometimes the results of these experiments are very harmful. One case was reported to me during my Investigation work that one girl student got her eyes burnt during the Chemistry Practical work. Unfortunately, no first aid treatment could be given to her as a result of which she lost her eyes after a few days. Hence it is very necessary to take care of these accidents.

"Prevention is always better than cure". Hence, all precautions to avoid accidents in the laboratory should be taken.Some periods should be devoted in training the students for bending glass tubings and for inserting glass tubes in corks etc. They should be warned against all careless handlings of strong acids, phosphorous, sodium etc. Students should not be allowed to taste anything without the permission of the teacher. They should take special precaution while handling inflammable substances as petrol, spirit, carbon disulphide etc.

Even after taking all these precautions, accidents do occur in the laboratories. Hence, we should be prepared to face these accidents. Each laboratory must have a 'First Aid Box' and a Fire Extinguisher. Science teacher must be trained for the First Aid Treatment. After giving the First Aid Treatment, serious and doubtful cases should be sent to the nearest Doctor. Science teacher must be present on the spot when the students perform some dangerous experiments. These precautions would

much help in minimising the number of accidents in the laboratory. The Science teacher will be able to avoid many complicated cases in which the sufferer or his people like to ~~the~~ go to the Court of Law or claim damages, etc. by taking the above precautions.

(III). Economy in the Laboratory -

Science is the most costly of all school subjects. Hence the Science teachers must take special care for the economy measures in the laboratories. Much money can be saved by taking proper steps for such economy measures in the laboratories. This money can be utilised better in buying other apparatus.

First of all, costly and delicate apparatus should be handled with great care and caution. The price of the costly chemicals as Mercury, Potassium Iodide etc., should be mentioned on the bottles containing them to give the idea of their costs to the students. Thus the students would not misuse them. Students should be warned to handle carefully the delicate apparatus as thermometers, resistance boxes, ammeters, galvanometers etc. Any apparatus requiring special care must be marked accordingly.

More attention should be paid towards the quality of apparatus w while purchasing them. Glassware of good quality should be purchased. Thus, there will be less breakages of test tubes, beakers, flasks etc. Those test tubes whose bottoms are broken should not be thrown away. The students can seal their bottoms again and thus they can be used again.

Gas, water and electricity should not be wasted. Students should be asked to use these economically. Similarly distilled water should not

be used where tap water can serve the purpose. Science teachers should take care to collect rain water as it can be used as distilled water. Similarly lime water can be prepared easily in the laboratory and it should not be purchased from the market. Wastage of chemicals and salts should be checked. Careless handling of apparatus should be stopped. Filter papers should not be misused by the students.

If a little care is taken by the Science teachers in the Laboratory, much money can be saved. Unnecessary chemicals and apparatus should not be purchased for the laboratory. Breakages of apparatus should be minimised. Some fine must be realised from the students for the breakages. This will make the students to be more careful in the laboratory.

(17). Repairs of the Apparatus -

During my Investigation work, I found that the laboratories are full of broken apparatus. A large number of apparatus are lying out of order and every year new apparatus are purchased in their place. Ordinary things can be repaired by the Laboratory Assistant with the help of the Science students under the guidance of the Science teachers. I have found that magnetometers, ammeters, galvanometers are lying in unworkable condition even for want of ordinary repairs.

Of course, some apparatus need specialist for their repairs. Generally no money is sanctioned for the repair work, for the laboratory. On the other hand, repairs are very necessary innthe Science laboratories. Audit rules must be made more liberal in this respect and the Science teachers should be given powers to spend money on the repairs' work.

I am sure, apparatus of lacs of rupees are lying in broken condi-

tion. I have advised the Managers of some Companies to start a new Department for the repair work of these Scientific apparatus. At present, no company is paying attention to the repairs of old and broken apparatus. During my investigation work, I found that Fortins barometers are not giving correct reading as air has entered in them. Physical balances are lying out of order as they have been not repaired and oiled, since a long time. The Laboratory Assistant should devote some time for the repairing work on the holidays.

(V). Recurring and Non-Recurring Grants -

At present, there is no definite policy in this respect. First of all the Authorities should take care to see that all the Higher Secondary Schools do not start Science classes without having well-equipped laboratories. Separate Grant for each type of laboratory should be given when the new laboratories are started in the Higher Secondary Schools. After consulting Science teachers and the Prospectus of the Higher Secondary Classes, I have come to the conclusion that an amount of Rs. 10,000/- is necessary for establishing new laboratories for Physics and Chemistry. Thus, an amount of Rs. 10,000/- will be required to start a laboratory for Physics and Chemistry for 100 students. This amount may be increased accordingly, if the number of Science students is greater. A Biology Laboratory requires Rs. 20,000/- as Botanical Garden and Friggery are also necessary for this laboratory. These amounts cover both the Recurring and Non-Recurring expenses.

At present, I have found that there is no Scheme for sanctioning Recurring Grant for the Science Laboratories. Higher Secondary Schools

of the cities are given more Grants while District Schools are neglected. There should be some Uniform Policy in this respect. A Grant should be sanctioned according to the number of Science students. Thus for a total of 100 Science students - an amount of Rs. 1,000/- should be given as a Recurring Grant to the Physics Laboratory. A Chemistry Laboratory needs more money as the substances used in the Chemistry Laboratory, cannot be recovered generally. Hence, an amount of Rs. 3,000/- should be granted for the Chemistry Laboratory. These Grants should be increased according to the number of the students. An additional grant of Rs. 200/- should be given to each laboratory for each additional 50 students. One point should be made clear that the total number of Science students includes students of IX, X and XI classes. A Biology Laboratory requires Rs. 2,000/- per year as a Recurring Grant. This laboratory has to maintain the Botanical Garden and the Froggery for the Practical work.

I have received Reports that in some of Institutions only Rs. 200/- are given for the purchases. How is it possible to meet all the expenses of the laboratories within this small amount ? Some Principals use this laboratory grant for some other purposes as in the buying of Safe, furniture, etc. The Government should sanction separate Grants for the Science Laboratories and this amount should be spent on the Laboratory purchases only. Principals should not be allowed to purchase other equipments for the Institution from this Grant. This Grant should be given directly to the Laboratory In-charge and there should be nom interference of the Principals in this respect.

(VI). Scheme for the Purchasing Apparatus and Chemicals -

At present, apparatus and chemicals are purchased through the

principals. The Principal places the orders to the Firm he likes. This procedure for the purchases for the laboratories is most defective. Generally the apparatus and the chemicals of poor quality are supplied at the higher prices. Thus I have found great dissatisfaction among the Science teachers in this respect.

The first important point is that the Science Teachers should have complete Freedom about the laboratory purchases. The Science Teachers should make a list of those things which are not available in the laboratory. They should also make an estimate about the quantity of these materials that would be required next year. They must invite quotations from at least three or four Firms of repute for these materials.

A Purchase Committee should be formed consisting of at least three Senior Science Teachers. They should first compare the rates and then place the Orders to the deserving Firms.

One point should be remembered in this respect - that other conditions as the packing charges, income-tax, transportation charges etc. should also be kept in view, while comparing the rates. All the details about the apparatus should be made clear. Time-limit for the supply of materials should be given to the Firms.

On receiving the materials, they should be checked and compared with the Invoice. Any breakages of the apparatus should be reported at once to the Firm.

All the apparatus and chemicals should be entered in the Stock Registers.

Only the 'low rates' should not be the criteria for placing the orders. The quality of the apparatus and chemicals should be considered, and judged seriously. The Purchase Committee should have full powers for placing the orders. There should be no interference from the Principals or the Clerk concerned.

Science Teachers should keep in view the recurring grant sanctioned for the purchases and in no case the amount should go above the amount of the sanctioned grant.

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Sixth Chapter

CHAPTER V.

CO-CURRICULAR ACTIVITIES OF THE SCIENCE LABORATORIES -

Outlines -

(I). Science Libarary.

(II). Science Club.

(III). Workshop.

(IV). Science Museum.

(V). Science Exhibitions.

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CHAPTER V.

CO-CURRICULAR ACTIVITIES OF THE SCIENCE LABORATORIES.

(I). Science Library -

From the data collected for my Investigation work, I came to know that only 10 % Institutions have separate Science Libraries. Generally, Institutions have one General Library. This General Library has a very poor stock of the Science books. Moreover, students do not get sufficient time and facilities for getting the books from this General Library, as there is only one Librarian and the number of the students is very large.

Good Institutions have separate Science Libraries. A Science Library can be more useful to the Science students and Science Teachers. This Library must have standard text books and advanced Reference books. A Subject-wise Library should be maintained. It should contain books on the History of Science, Life History of Prominent Scientists etc. It should also contain some books useful for the Exhibition purposes. It should have books of subjects like 'What to look for', 'How to make' and 'What to do'. Besides such types of books, it must also have books on 'Simple Science', 'Wonders of Science' etc. Additional Text Books and University Text Books should be purchased for this Libary for reference purposes and for the general reading.

Finally, it ought to have a good number of Scientific Periodicals and Journals.

This Library should be managed with the help of Laboratory Assistant and Senior Science students. Students should have free approach

hand-made apparatus. Some students can demonstrate interesting experiments.

Biology students can collect the data about the local flora and fauna. They can collect Observations of the Results of the attempts to grow the Plants in various soils and under different conditions.

Cinema Show and Slides show can also be arranged for the students. They can also publish the Science Magazines.

All these activities of the Science Club can make the Science teaching more fruitful and interesting. These activities can stimulate the pupils' participation and initiative in the learning of Science in its real sense.. Properly organised Science Clubs will raise the standard of the Science Instruction in the Schools.

(III). Workshop -

Though the Laboratories have sufficient tools for the workshop, yet the students do not use these tools for the simple repair work of their daily life. Hence, it is better to arrange a systematic workshop in a separate room for the students. Students should have a free approach to this workshop for their work.

Facilities and apparatus should be provided for electroplating, photography, soap-making, ink and candle-making etc. Students should be given training in the electric repairs. They should be trained to repair their cycles, stoves, fountain-pens, pumps etc. As these things are very common now a days and the students pay much even for the small repairs work in the market, the Science students should be able to repair these things. Some Specialist may be called to train the students for these

students have reported that they do not get money from the Institution for preparing things for this Exhibition. Only 27 % students have reported that they prepared something for this Exhibition. This number is certainly very ppor. Moreover, the students have also reported that they do not get any encouragement for this Exhibition even in the form of marks prescribed for their School work by the Board of Examination.

Hence, the students should be encouraged to take part in these activities by giving them marks from their scheduled School marks for the work allotted there. Generally, the students are very much interested in the Experiments and Models of Science. Dangerous experiments must be left out. Even the lazy and the dull students would like to take part in these activities provided they are motivated by the Science Teachers. They should also be given Prizes for their excellent work.

Science Teachers can give books on experiments and models to the students from the Science Library and the students may be asked to prepare things with their help. Any how they would manage to do something for this Exhibition. A Committee of the Senior Students should be formed to organise this Exhibition and the Science Teachers can guide the students only. The Principal can give at least an amount of Rs. 200/- for this Exhibition work.

There are many advantages of these Exhibitions. Parents and friends would pay a visit to the Institution and they would be able to see what their students have done in the school. The students would also get a real joy for doing some creative work. They would thus learn many things by such an Exhibition work. They would realise the value of their manual

No. 9

Model For Exhibition.

future.

All the above co-curricular activities are very essential in the modern world. Other countries are paying more attention towards these activities. These activities can make Science a living and an interesting subject. These activities should occupy an important place in the Curriculum of the Higher Secondary education. Only the Science Teachers can encourage and start these activities in the Institution. Of course, they will have to give some time and energy for these activities, but they will certainly strengthen the Science Teaching in India. Good and well-balanced students would be produced with the help of such activities.

Photograph No. 9 - shows a Model of the apparatus for the manufacture of sulphuric acid by contact process. This Model is prepared from cotton only.

This Model was placed in the Science Exhibition in the Maha-Rajwada, Ujjain. Different Institutions took part in that Science Exhibition. They placed many Models, Charts etc., in that Exhibition. These two students won the First Prize. They worked hard for this Model and their work was given the due credit.

Such types of activities can be encouraged only if the Science Teachers take proper interest and show more enthusiasm in their work. The students require their guidance and they need encouragement from them for these types of activities.

If the Science Teachers get sufficient time and proper facilities they would encourage such activities in the Higher Secondary students. More attention should be given to these activities. At

present, 63 % Institutions arrange the Science Exhibitions. Each Institution should arrange the Science Exhibition at least once a year.

Sixth Chapter

CHAPTER VI.

INTERPRETATION, CONCLUSIONS AND SUGGESTIONS.

Outlines -

(I). Interpretation of Data.

(II). Conclusions and Suggestions.

  (1). Minimum Standard for the Science Laboratories in the Higher Secondary Schools.

  (2). Recurring and Non-Recurring Expenses for these Science Laboratories.

  (3). The Necessity of Special Type of Training Courses for the Science Teachers in the Training Colleges.

CHAPTER VI.

INTERPRETATION, CONCLUSIONS AND SUGGESTIONS.

(I). Interpretation of Data -

For my Investigation work my Sources of Data are Questionnaires, Visits and Interviews. Two Kinds of Questionnaires were circulated for knowing the existing condition of these Science Laboratories in the Higher Secondary Schools. Questionnaires Part 'A' were circulated among the Science Teachers and Lecturers in the Higher Secondary Schools. Questionnaires Part 'B' were sent to the Science students of XI Class.

Numbers of Responses received are given below in Table No. II.

TABLE NO. II.

Returns of Questionnaires.

S.No.	Questionnaires. No.	No. of Questionnaires sent.	Responses received in the 1st attempt	Responses received after reminder.	Total No. of responses received.	% of the responses received.
1.	2.	3.	4.	5.	6.	7.
1.	Part 'A'. 'For Science Lecturer.	100	50	20	70	% 70
2.	Part 'B'. For Science Students.	150	75	25	100	67

TABLE NO. III.

Responses to Questionnaires Part 'A'.

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
				%
	Laboratory Fittings and Furniture.			
1.	Separate Laboratories for Physics, Cehemistry and Biology.	70	29	41.4
2.	Institutions having the following arrangements for the Laboratories -			
	(a). Dark room.	70	7	10.0
	(b). Electric fitting.	70	42	60.0
	(c). Water taps.	69	27	39.0
	(d). Sinks.	70	38	54.0
	(e). Gas Plant.	70	11	16.0
3.	Institutions providing stools to students in the laboratory.	67	19	28.4
4.	No. of Periods devoted per week for Practical work:			
	(a). Four periods.	68	38	56.0
	(b). Two periods.	68	30	44.0
	Laboratory Staff -			
5.	Institutions having separate Laboratory Assistants for different types of Laboratories.	70	17	24.3
6.	Institutions having no Laboratory Assistant.	70	15	21.4

Table No. III. (Contd.).

Responses to Questionnaires Part 'A' (Contd.) -

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
	Laboratory Staff (Contd.) -			%
7.	Institutions having separate laboratory peon for each type of Laboratory.	70	11	15.7
	Teaching Load.			
8.	No. of periods given to Science teachers per week:			
	(a). 30 periods per week.	70	42	60.0
	(b). 36 periods per week.	70	13	18.6
	(c). 42 periods per week.	70	15	21.4
	Laboratory Records -			
9.	Institutions maintaining the following Laboratory records :			
	(a). Stock Register for perishable articles.	70	62	88.6
	(b). Stock Register for Non-perishable articles.	70	59	84.3
	(c). Issue Register.	70	40	55.6
	(d). Breakage Register.	70	40	55.6
10.	Institutions charging fines for breakages.	70	37	52.9
	Laboratory Grants -			
11.	Recurring Grants to different Laboratories :			

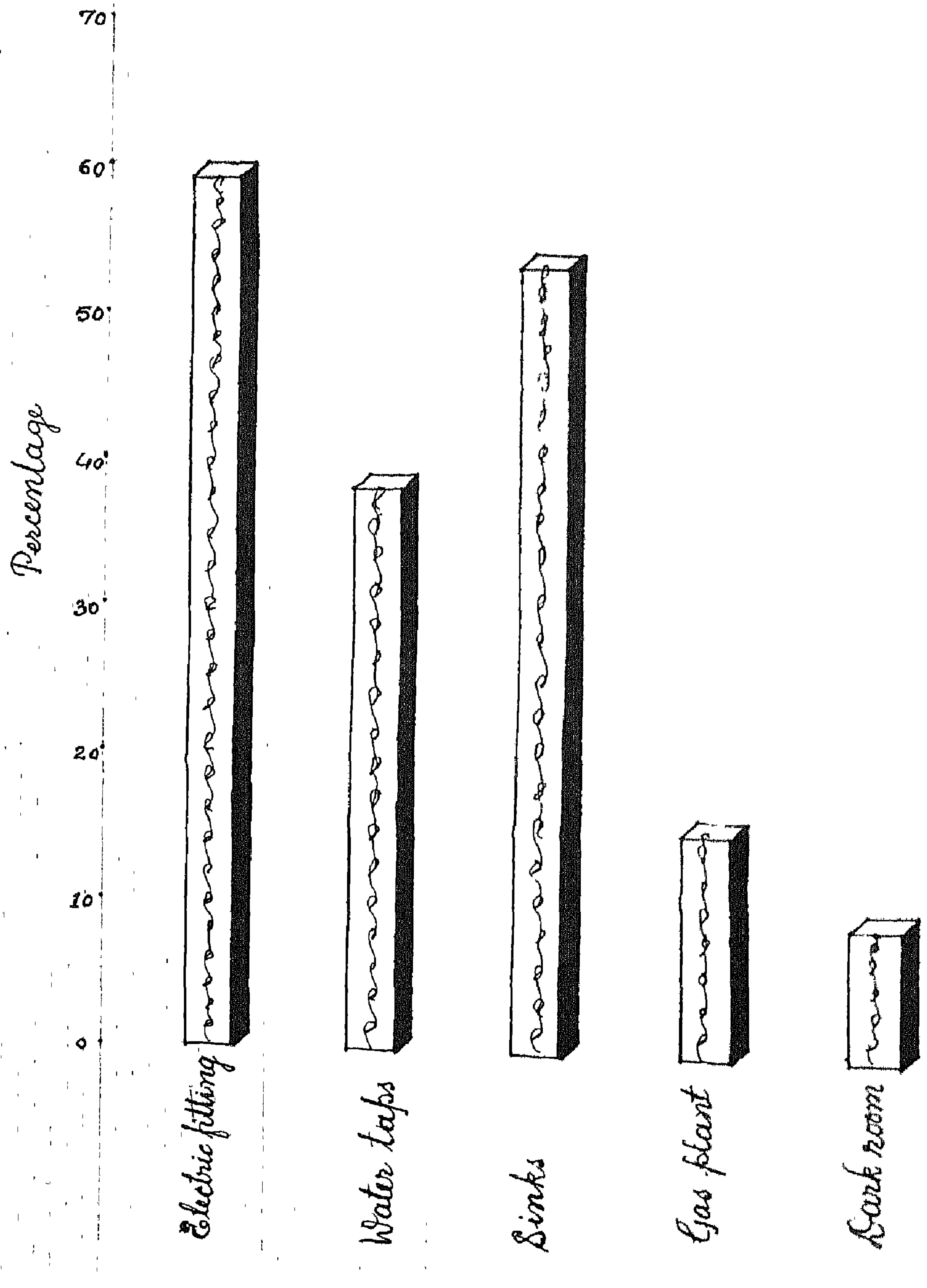
Table No. III. (Contd.).

Responses to Questionnaires Part 'A' (Contd.) -

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
	Laboratory Grants -			%
11.	Recurring Grants to different Laboratories :			
	(A). Physics Laboratory :-			
	(i) Upto Rs. 500/-	60	55	91.7
	(ii) Rs. 500/- to 1,000/-.	60	4	6.7
	(iii) Rs. 1,000/- to 1,500/-.	60	1	1.6
	(B). Chemistry Laboratory :			
	(i). Upto Rs. 500/-.	60	54	90.0
	(ii). Rs. 500/- to 1,000/-.	60	5	8.4
	(iii). Rs. 1,000/- to 1,500/-.	60	1	1.6
	(C). Biology Laboratory :			
	(i). Upto Rs. 500/-.	46	45	97.8
	(ii). Rs. 500/- to 1,000/-.	46	1	2.2
	(iii). Rs. 1,000/- to 1,500/-.	46	0	0.0
12.	Co-curricular activities of Laboratories -			
	(i). Science Club.	70	36	51.0
	(ii). Workshop.	70	4	6.0
	(iii). Science Library.	70	7	10.0
	(iv). Science Exhibition.	70	44	63.0
	(v). Science Fairs.	70	8	11.0
	(vi). Botanical Gardens.	70	14	20.0
	(vii). Froggery.	70	7	10.0
	(viii). Show cases for Biological Specimens.	70	21	30.0

Fig. No. 5.

Laboratory fittings



First, I would like to discuss the responses received in reply to the questionnaires, Part 'A'. Table No. 11 gives the details of these responses.

Responses to Question I (a) show that only 41.4 % Institutions have separate Laboratories for Physics, Chemistry and Biology, while it is very necessary to have separate laboratories for these subjects to cover the Practical Courses of the Higher Secondary Classes. All the Science Lecturers are of the view that separate Science Laboratories are necessary for the Higher Secondary Schools as is clear from the responses of question No. I (b).

Answers to Question No. I (c) show that only 10 % Institutions have Dark Rooms which is very necessary for the experimental work in light for Physics Laboratory. Only 16 % Schools have Gas Plant while it is very difficult to do Practical work in the Chemistry Laboratory without the Gas Burners. Only 54 % Institutions have the Sinks fitted in the Practical Tables. 39 % Schools have the Water taps arrangement in the Laboratories and 60 % have the Electric Fittings. These facts are shown in Diagram No. 5.

All these arrangements and fittings are essential for the Science teaching. In their absence, Science teaching suffers and the standard cannot be raised upto the set mark.

Answers to question No. I (d) show that 70 % Institutions cannot afford to have the minimum laboratory floor area per student which is 30 square feet and the students do their Practical work in the over-crowded laboratories. These are the main causes for lowering the standard of

No. 1.

CHEMISTRY LABORATORY.

Science teaching in the Higher Secondary classes.

In question No. 11, four sub-questions were asked to gather informations about the types of Furniture used in these Laboratories. Answers to question No. 11 (a) and (b) show that the sizes of the Practical tables differ very much from Institution to Institution. Some prefer to use long benches while others prefer smaller ones. The number of students who work on one Practical Table range from [illegible]. In short, no uniformity is maintained. After visiting the above Laboratories, I came to the conclusion that different types of Practical benches are required for Physics, Chemistry and Biology Laboratory. In the Physics Laboratory - we require long Practical tables without the Sinks and Gas Burners. The most economical size of the Practical tables is 20 feet long and 3 feet wide and 6 students can work easily on each table. We can have two tables each 10 feet long.

For the Chemistry Laboratory - there should be double benches of dimensions 12 feet long, 4½ feet wide and 5 feet high. Six students can comfortably work on each practical table. This is very economical size as two students can have common Reagent bottles on the shelf between them.

Photograph No. 1 -

shows Higher Secondary Students working in a separate Chemistry Laboratory. This Photograph shows clearly the shelves containing Reagent bottles. One shelf is divided into two parts and 4 students can work on each shelf two on each side of the shelf. The Practical table does not have sink fitted in it and a glass dessicator is placed in place of a sink. Students can work very comfortably in such a type of separate Chemistry

No. 2.

PREPARATION ROOM
FOR
CHEMISTRY LABORATORY.

Laboratory but in the Higher Secondary Schools of Madhya Pradesh only 41.4 % Schools have separate laboratories for these subjects. 58.6 % Institutions have one common laboratory for all the three subjects i.e., Physics, Chemistry and Biology. This Photograph gives the view of Chemistry Laboratory having ideal arrangements of Science Laboratories.

Photograph No. 2 -

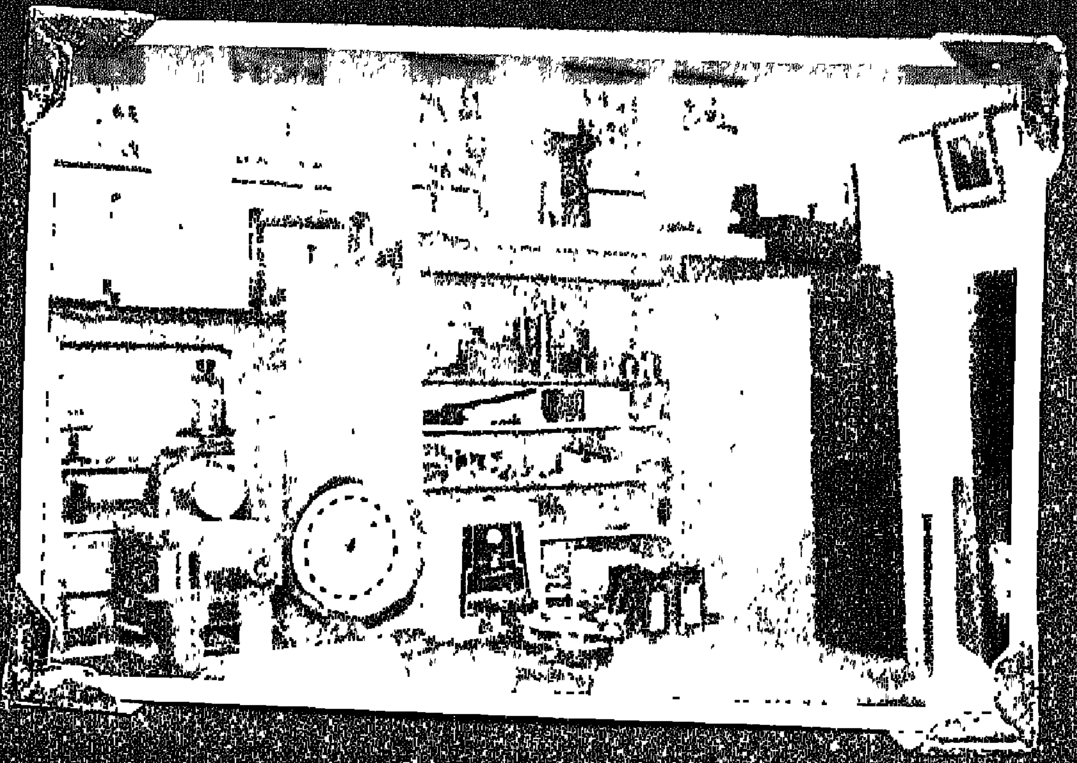
shows the preparation and store-room for Chemistry laboratory. This room should be attached with the main Chemistry laboratory. This room is very convenient a place for preparation purposes and for storing the salts, chemicals, acids etc., in a safe place. Laboratory Assistant and Science Teacher can prepare the chemicals in this room comfortably. Chemical apparatus can also be placed in this room. This Photograph shows the Laboratory Assistants preparing solution for titration work. This is the ideal situation in the Higher Secondary Schools of Madhya Pradesh. 80 % institutions have no separate store rooms and all the above chemicals and apparatus are stored in the small main laboratory. This causes great inconvenience for Science students during their experimental work.

If the standard of teaching of Science is to be raised and if more fruitful results are desired, then the above arrangements should be made in every Science laboratory without delay. More attention should be given to the standard of Science laboratories than to increase the number of the Higher Secondary Schools having Science as an optional subject.

No. 3.

PHYSICS LABORATORY.

No. 4.



STORE ROOM
FOR
PHYSICS LABORATORY.

Photograph No. [illegible]

[illegible] doing their experimental work in the Physics laboratory. [illegible] required long practical tables without [illegible]. This photograph shows, how comfortably the students can work on [illegible] tables. Moreover, they are economical, as more experiments can be arranged on one such table.

[illegible] conditions cannot be fulfilled in one common Science laboratory and hence a separate Physics laboratory is a necessity for [illegible] Higher Secondary schools.

Photograph No. 4.

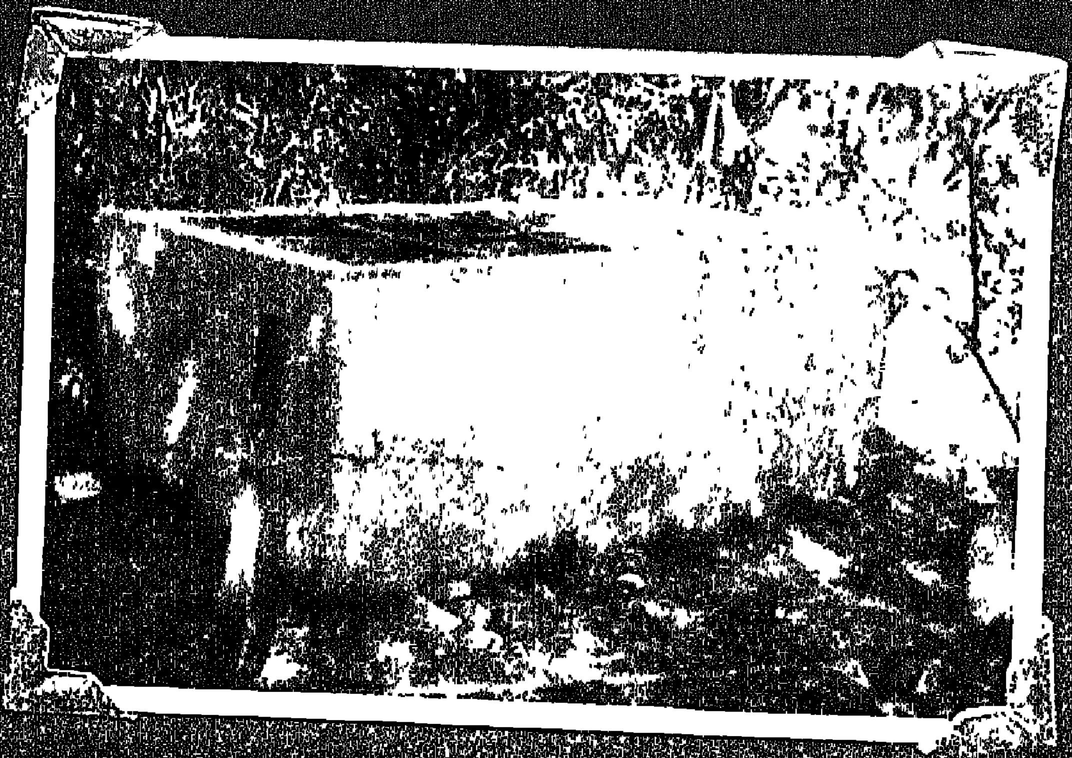
Shows a view of the store room of a Physics laboratory in an Ideal Higher Secondary School of Madhya Pradesh - (Maha Rajwada Higher Secondary School, Ujjain). All the apparatus for the light experiments are arranged in a systematic way in one separate almirah. Similar almirahs are arranged for other types of apparatus. This store room is very necessary for Physics laboratory.

The main laboratory should have only specific apparatus required for particular experiments assigned for the particular day. Other apparatus can be stored in store room. The procedure will facilitate the working of laboratory. Students can work more comfortably and can concentrate in their experiment more if the above arrangements are made in the Science laboratories. These arrangements are made in 41.4 % Higher Secondary Schools of Madhya Pradesh. These laboratories are well-equipped and give better facilities for the experimental work.

No. 5.

BIOLOGY LABORATORY.

No. 7.



FROGGERY.

In [illegible] the proper size of the practical table is [illegible] and four students can work on each bench. [illegible] not work on each bench as they have to use [illegible] for their experimental work. Froggery and Botanical garden [illegible] this laboratory.

Photograph No. 5 -

Shows the students doing Dissection work in the Biology laboratory. [illegible] with microscopes and hence sufficient diffused daylight [illegible] is very necessary for this laboratory. The practical benches [illegible] without shelves, sinks etc., as they are not required in this laboratory. A single long practical table is shown in this photograph for working purposes.

A Botanical Garden is very necessary according to the present syllabus. Only [illegible] % institutions have the Botanical Gardens at present.

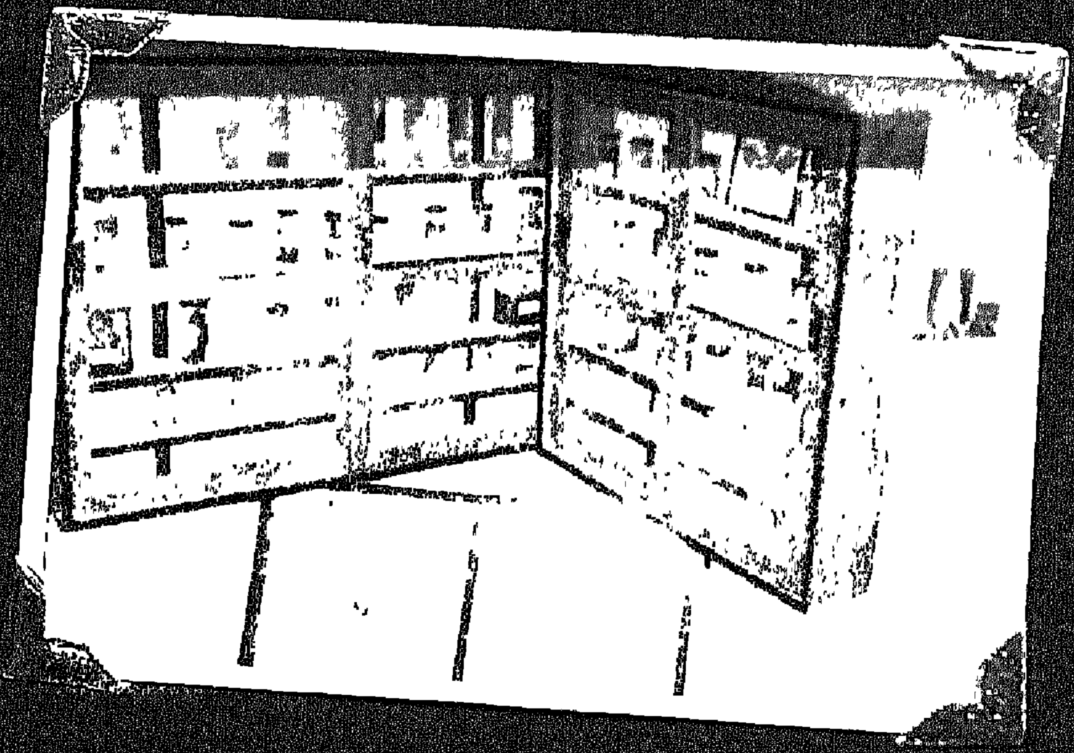
Photograph No. 6 -

Shows a Biology class in the Botanical Garden. This Garden has all the Plants and Flowers included in their Syllabus. Thus they are not required to go to some other Garden every now and then to study Plants and Flowers.

Photograph No. 7 -

Gives a view of froggery in Maha Rajwada Higher Secondary School, [illegible]. At present only 10 % Institutions have froggery while froggery is very necessary for the Higher Secondary Schools according to the

NO. 8.



SHOW CASE.

practical classes in Biology.

I have found Institutions searching for frogs before one week of the practical examination for the dissection work. This situation can be avoided, if they have their own froggery and the students can have more practice in the dissection work. Moreover, this froggery and its maintenance is not very costly. They can easily be maintained in a Higher Secondary School.

Suggestion No. 3 -

Make a proper show case for the specimen bottles for Biology laboratory. Each show case has shelves divided into five compartments of different sizes to suit the different sizesof specimen bottles. These show cases can be fixed on the wall side at a height of 4 feet. The students can learn much by looking at these specimens and these show cases will prove very useful at the time of the School Exhibition. At present, only 30 % Institutions have this type of arrangement in their Biology laboratory.

50 % Institutions do not have sufficient number of almirahs to store apparatus and chemicals and hence they are not safe in the open places. Each laboratory must have at least 6 almirahs to store apparatus and chemicals. Only 28.4 % Institutions provide stools to the students during the laboratory work, while they are very necessary as the students cannot stand for a long time during their practical work. The height of these stools should range from 22 inches to 25 inches to suit the students of the different heights.

Question No. 3 deals with the Problem of time devoted to the practical work. My data show that 56 % Institutions devote four periods per week for the practical work in each subject i.e., Physics, Chemistry and Biology. But 44 % Institutions devote only two periods per week for the practical work. Thus the students get only one turn per week for their experiments for each subject. This time is not sufficient to cover the practical courses of XI class. After visits and interviews I came to the conclusion that 4 periods per week of 40 minutes each should be devoted for the practical work in XI class. Thus the students will get two turns per week for doing their experimental work in each subject. 56 % Institutions are giving 4 periods per week at present. The Board of Secondary Education should frame the Rules regarding the time to be devoted for the Practical work.

Question No. 4 deals with the Laboratory Assistant and Peons. My Investigation work shows that 75.7 % Institutions have only one common laboratory assistant for all the three laboratories. Thus he is over-burdened and therefore cannot do his work efficiently. This lowers the standard of these laboratories. I have come to know that 15 out of 70 laboratories do not have laboratory assistants at all and they engage Science teachers for the laboratory work which proves very costly to the Department. Hence, it is very necessary to create more posts of the laboratory assistants for each Institution. Each type of laboratory must have one full-time laboratory assistant. He should not be engaged in the office work. He must be in the laboratory during the working hours. Same is the case with the laboratory peons. One peon for each laboratory is necessary. This is the practice in the Science laboratories in the

Degree Colleges. This should also be done for the Higher Secondary Schools. To raise the standard of these laboratories is a serious problem and it should be solved sincerely. Only debates and discussions in the Seminars cannot solve these problems.

The next important problem is about the load of the teaching periods for the Science teachers. At present, the Principals and other officers of the Education Department do not realise the difference between the nature of the working of the Science teachers and other teachers.

Question No. 5 deals with this problem. Responses to my Questionnaires show that 21.4 % Science teachers have to take 42 periods per week, at present, and 18.6 % teachers take 36 periods per week. Besides, this, they have to look after the laboratory work and this time is not taken into account in their duty hours. This discourages them and the laboratory and the practical work therefore do not get their proper attention.

After consulting the Senior Science teachers, I came to the conclusion that a Science teacher must have 24 teaching periods per week, including the Practical periods. 6 periods per week should be given for the laboratory work. Thus the time devoted for the laboratory work, should also be taken into consideration. This procedure will encourage the Science teachers and they would pay more attention towards the laboratories and the Institutions would have better and well-organised Science Laboratories.

In question No. 6, I have dealt with the problem of keeping the different laboratory records. These laboratory records should be kept

regularly and systematically. If this work is not done properly, then the In-charge of the laboratory would find much trouble at the time of the stock-checking or when the handing over the charge of the laboratory to the other person at the time of his transfer.

I have come to know that the Stock Registers for the perishable and the non-perishable articles are maintained by most of the Institutions but only 35.6 % laboratories have the Issue and Breakage Registers. These two Registers are also very important for the laboratories. Breakage Register is helpful when used up articles or broken apparatus are to be written off from the Stock Registers at the end of the Session. Entry in this Register should be made at the very moment of the occurence of the breakages. This record can afford up-to-date information about the used up articles or the broken apparatus.

Moreover, this information can also guide us in preparing a list of the chemicals and apparatus to be purchased for the next Session. An Issue Register can give us a clear idea about the apparatus which has been issued to some Department or to some person and we can recover it in time. If this record is not kept properly, we can forget to recover it from the concerned person.

52.9 % Institutions charge some fine and recover from the students for the breakages. I think that this fine is necessary for the careful working of the Science students in the laboratories. This procedure can reduce the breakages in the laboratories. I have found that some In-charge of the laboratories ask the students to replace the broken apparatus. This procedure is better as there will be no shortage of the apparatus and new apparatus will be substituted in place of the broken apparatus.

It is very important to check the stock of the laboratory every year to get a clear picture of our stock. This is helpful in arranging the apparatus at their proper places and in finding out the missing apparatus. Stock checking is done by all the Institutions at the end of the session.

Then I have also discussed the most important problem of Recurring Grant to the Science Laboratories, in question No. 7. My data show that 91.7 % laboratories get Rs. 500/- or less as their Recurring Grant per year. This amount is not sufficient for meeting the expenditure of these laboratories. Moreover, I have come to know that there are no Departmental Rules about this grant, and it depends upon the whims of the Principal. If the Principal is a Science hand he may grant sufficient money otherwise this grant is very poor. After consulting the courses in these subjects and many Science teachers, I came to the following conclusion about the Recurring Grant for these laboratories :-

Physics laboratory needs a Recurring grant of Rs. 1,000/- per year.
Chemistry laboratory needs a Recurring grant of - Rs. 3,000/- per year,
and Biology laboratory needs a Recurring grant of - Rs. 2,000/- per year.

These grants are for those Institutions which have one Section for each class i.e., IX, X and XI.

If the total number of Science students from IX class to XI class is more than 100, then for each 50 additional students, an additional grant of Rs. 200/- should be given to each type of laboratory. My Investigation work shows that at present 90 % Science teachers are not satisfied with the recurring grant given to these laboratories. This

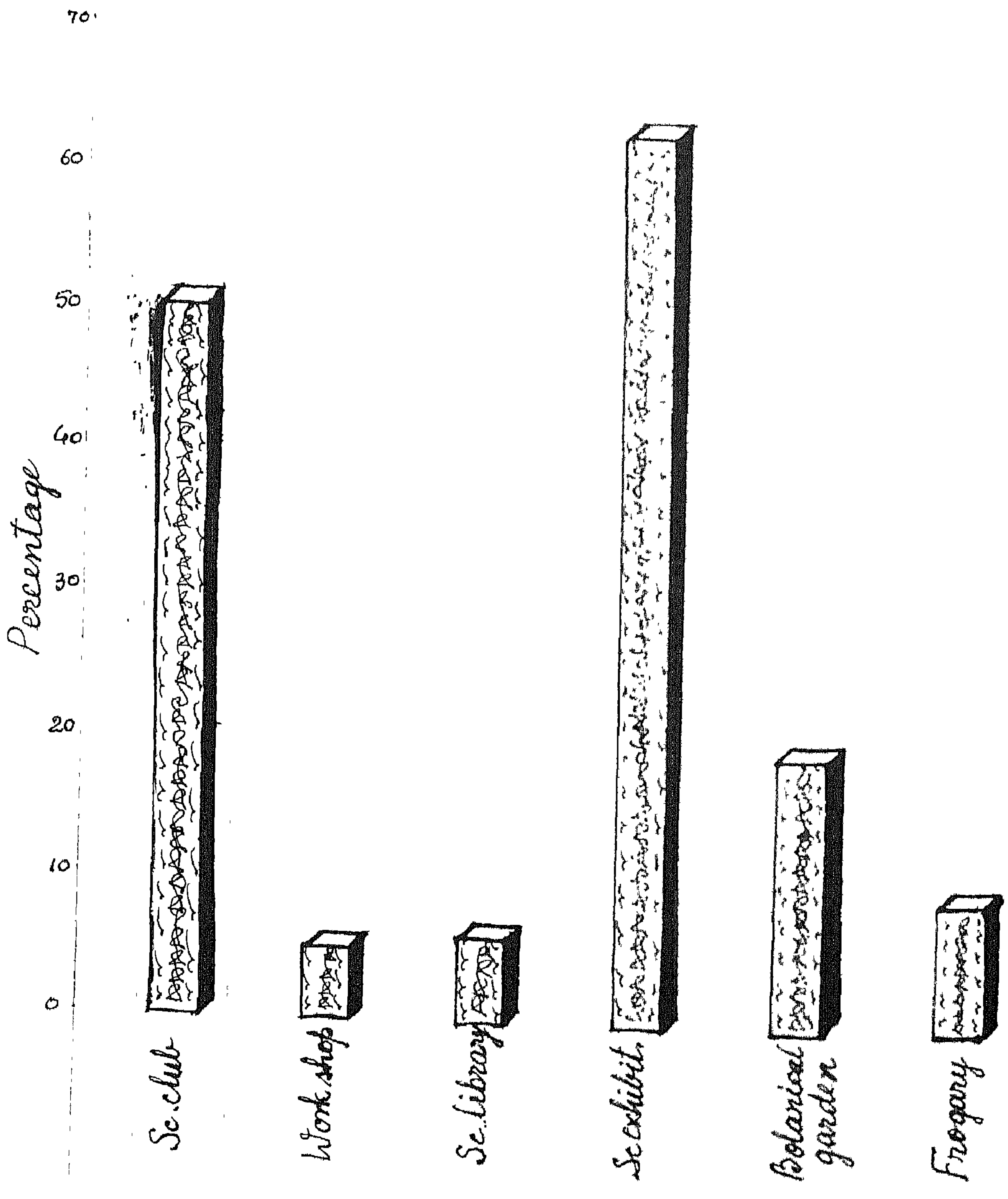
proves very harmful for the Science students as no practical work is done in IX and X classes in 90 % Institutions. For removing these defects the above suggestions about the recurring grant should be seriously followed:-

Question No. 8 deals with the problem of the Purchases for these laboratories. My data show that in 40 % Institutions the Principals do not consult the concerning Science teachers about the purchases for the Science laboratories. They themselves place the order to the Firms in which they are interested. This results in the supply of the inferior type of apparatus and chemicals and the Science teachers and the Science students have to face much difficulty during their Practical work. Hence it is very essential to consult the Science teachers for these purchases. Science teachers should be made fully responsible for these purchases. They should be authorised to make the purchases from those Firms which they like.

I came to know that only 64 % Institutions invite quotations for making these purchases. After my Investigation work, I came to the conclusion that a Purchase Committee of 3 Senior Science teachers should be formed in every Institution. This Committee should call the Tenders from at least 3 Firms and they should compare the rates. The order should be placed to the firm quoting the least rates, but the quality of the article and other charges as Sales-tax, Packing charges, Transportation charges etc., should also be considered. This Committee should be authorised even to make purchases from the Firms quoting high rates for the sake of the quality of the article. In short, there should be no interference

Fig No. 6.

Co-curricular activities
in
Science laboratories



[illegible] authorities in the matter of the Laboratory [illegible].

[illegible] the addresses of some well-known Firms dealing [illegible] Scientific materials. A list of 26 addresses of such Firms is [illegible]. This list will prove very helpful at the time of [illegible] for the laboratory purchases.

[illegible] with the problem of extra-curricular activities of these laboratories.

[illegible] of Institutions having different co-curricular activities [illegible] Diagram No. [illegible]. These activities should be [illegible] every Institution by providing proper facilities. These activities will prove very useful for the students. These activities will create more interest and love for the Science subjects. These can make Science a living subject as the students are more interested in doing a thing rather than in knowing the theory of it only.

Students should be encouraged to take part in these activities by giving [illegible] 5 % marks assigned for their school work in each subject by the Higher Secondary Board. At present only 43 % Institutions are giving marks for these activities.

In the end, I have collected some very useful suggestions to improve the present poor condition of these laboratories of the Higher Secondary Schools.

A list of these suggestions is given below :-

(1). Laboratory Assistant and Science teachers should be trained for the

the Management and Organisation of the Science Laboratories.

(2). Every Laboratory should have a workshop for the small repairs.

(3). There should be a Froggery and a Botanical Garden in every Institution attached with the Biology Laboratory.

(4). Laboratory purchases should be made simple and easy.

(5). There should be separate provision for the Practical periods in the Time-tables.

(6). Institutions having poor Science Laboratories should not be recognised for the teaching of Science.

(7). Some money should be sanctioned for the Science Exhibition and students taking part in this Exhibition should get some help from ~~th~~ this amount.

These Suggestions deserve consideration for raising the standard of these laboratories.

On the following page, are givan the Responses to Questionnaires Part 'B' (from the Science Students of XI Class) in a Tabular Form - in Table No. IV.

(P.T.O.).

TABLE NO. IV.

Responses to Questionnaires Part 'B'.

(From the Science Students of XI Class).

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
				%
1.	Students who did Practical work in IX Class in -			
	(a). Physics.	100	1	1.0
	(b). Chemistry.	100	1	1.0
	(c). Biology.	98	0	0.0
2.	Students who did Practical work in X class in :			
	(a). Physics.	98	57	58.2
	(b). Chemistry.	98	41	41.8
	(c). Biology.	97	0	0.0
3.	No. of students in one Group for the Practical work :			
	(a). Physics - Individually.	97	19	19.6
	Group of 2 students.	97	63	64.9
	Group of 3 or more.	97	15	15.6
	(b). Chemistry - Individually.	100	64	64.0
	Group of 2 students.	100	17	17.0
	Group of 3 or more.	100	19	19.0

Table No. IV. (Contd.).

Responses to Questionnaires Part 'B'.

(From the Science Students of XI Class).

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
				%.
3.	No. of students in one Group for the Practical work (contd.).			
	(c). Biology -			
	Individually.	49	27	55.1
	Group of 2 students.	49	9	18.4
	Group of 3 or more.	49	13	26.5
4.	First Aid Treatment.	100	25	25.0
5.	Fine for the breakages in the Laboratory.	100	93	93.0
6.	No. of Institutions having the following arrangements :			
	(a). Science Library.	100	1	1.0
	(b). Science Club.	100	20	20.0
	(c). Workshop.	100	0	0.0
	(d). Science Museum.	100	0	0.0
7.	Institutions arranging Science Exhibitions.	100	58	58.0
8.	No. of students who prepared something for the Science Exhibition -			
	(a). Experiments.	100	27	27.0
	(b). Models.	100	17	17.0
	(c). Charts.	100	16	16.0

Table No. IV (Contd.).

Responses to Questionnaires Part 'B'.

(From the Science Students of XI Class).

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
				%.
9.	No. of the students who got some marks for this co-curricular work.	95	20	21.0
10.	No. of students who received money for these activities from -			
	(a). School.	93.	3	3.2
	(b). Home.	93	63	67.7
11.	No. of students having satisfaction for these laboratories -			
	(a) Physics Laboratory -	100.		
	Full satisfaction.		9	9.0
	Ordinary satisfaction.		41	41.0
	Not satisfied.		50	50.0
	(b) Chemistry Laboratory -	100.		
	Full satisfaction.		13	13.0
	Ordinary satisfaction.		37	37.0
	Not satisfied.		50	50.0
	(c) Biology Laboratory -	56		
	Full satisfaction.		3	50.4
	Ordinary satisfaction.		17	30.4
	Not satisfied.		36	64.3

Table No. IV. (Contd.).

Responses to Questionnaires Part 'B'.

(From the Science Students of XI Class).

S.No.	Information.	No. of responses received.	No. of 'Yes' responses.	% of 'Yes' responses.
1.	2.	3.	4.	5.
				%.
12.	Behaviour of the Laboratory Assistant -	100		
	(a). Very satisfactory.	100	31	31
	(b). Satisfactory.	100	30	30
	(c). Ordinary.	100	36	36
	(d). Not satisfactory.	100	3	3

Table No. IV gives the details of the ~~Expenses~~ RESPONSES given in reply to Questionnaires Part 'B'.

Questionnaires Part 'B' were filled up by the Science students of XI Class. These responses give a clear picture of these laboratories. They throw light on the following points :-

(I). Generally Practical work in IX class is neglected as is clear from the fact that only 1 % student do practical work in Physics and Chemistry. In Biology, they have no practical work in IX and X classes. As the figures show, there is no practical work even in X class in Biology. 58.2 % students do their practical work in Physics in X class and 41.8 % in Chemistry in X class.

These figures are very disheartening. The Board has prescribed

definite courses for the practical work for IX and X classes also. Students are expected to complete these courses in the respective classes. Now these Practical courses are not completed in IX and X classes and the students have to complete their whole course in XI class. Thus, they are over-burdened in XI class and they get, therefore, little time for their revision work. This procedure, therefore, naturally proves very harmful.

(II). The students do their practical work in Groups. A Group of 2 students in Physics Practical work can be tolerated. In Chemistry - individual students should do their practical work. In Biology also - individual students should do this practical work. These subjects require thorough practice. No two students can work with one burette in titration experiment. At present the students have to work in Groups due to the insufficient number of apparatus in these laboratories. The result of this procedure is very harmful as this kills the interest of the students for Science and they lack in skills.

(III). Only 25 % students get the First Aid Treatment in the laboratory. Sometimes the minor injury turns into a dangerous one and hence the First Aid Treatment should be arranged in these laboratories.

(IV). 93 % students have to pay fines for the breakages and the amount realised is deposited in the Treasury. The broken apparatus are not replaced. The better procedure is to ask the students to replace the broken apparatus.

(V). Only 1 % students use the Science Library. Only 20 % Institutions have the Science Clubs. There is no provision for the workshop and the Science Museum in the laboratories. These co-curricular activities are very important. The students learn much by taking part in

these activities. Every institution should have these activities. The Science Exhibitions should be arranged by all the Institutions. A financial help should be given to the students for preparing the Models and Charts for their Exhibition. At present, only 3 % students get this kind of help. Moreover the students should be encouraged for taking part in these activities by an allotment of marks for these activities. The Board has authorised every subject teacher to allot 5 % marks for the work done by the students in their subject for the Final Examinations. Proper record should be maintained for this, for all the three classes - IX, X and XI. If these points are observed, more students will take part in these co-curricular activities.

(VI). 39 % students are not satisfied with the present condition of the laboratories in the Higher Secondary Schools. They want separate laboratory rooms for their Physics, Chemistry and Biology. They want sufficient and proper apparatus for their practical work. They require sufficient time for their Practical work. Separate Laboratory Assistants should also be appointed for each laboratory.

If the above defects of these laboratories are removed, only then, a proper experimental work can be done in these laboratories. Then and then alone, a better result of the Science teaching can be expected. Only starting Science classes with poor laboratories cannot improve the knowledge of Science. Poor laboratories cannot produce new Inventions and Prominent Scientists. Hence the standard of these poor laboratories should be improved at any cost, without any further delay.

(II). Conclusions and Suggestions :-

(1). Minimum Standard required for the Science Laboratories in the Higher Secondary Schools for the recognition for the teaching of Science Subjects -

I am of the opinion that some minimum standard should be decided for the Science Laboratories of the Higher Secondary Schools. This minimum standard should be thus fulfilled before granting affiliation to the Institution for starting the Science classes. During my Interviews with the Principals and the Science Teachers, I came to know this very fact. In support of this view, I would like to quote a few lines from the Report of the Secondary Education Commission of 1952 :

> "We feel that this would be all the more necessary in the diversified courses of study, which we are recommending, and unless such a Scheme is adopted, we are afraid that Schools may get affiliated for such diversified courses of instruction, without having the necessary equipment and appliances and the theoretical type of instruction will seriously impair the value of such courses. We recommend, therefore, that Expert Committees should be appointed to lay down the equipment required for each of these diversified courses, including the workshop equipment and the number of pupils that can be conveniently accommodated in the workshop."[1]

Thus, it is very necessary that some definite minimum standard should be decided for the Science laboratories in the Higher Secondary Schools. At present only some formality is observed by the Board of

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[1] Report of the Secondary Education Commission 1952. p. 208.

Secondary Education in granting affiliation for the Science teaching. Institutions having very poor laboratory equipment conduct the Science classes. This practice should be stopped and suitable and proper rules should be framed for the Recognition of these Science Laboratories. With the help of my Investigation work, I have come to the conclusion, that the following conditions should be fulfilled by the Science Laboratories of the Higher Secondary Schools :-

(A). General Requirements for each type of Laboratory -

(1). Each Institution should heva a separate laboratory room for Physics, Chemistry and Biology.

(2). Each laboratory should have one full-time laboratory assistant and one peon.

(3). Institutions should make definite provisions for the practical work in the Time-table. At least, 2 turns per week, should be provided to the students, for the practical work in each Science subject.

(4). There should be separate lecturers for Physics, Chemistry and Biology.

(5). Physics laboratory should be granted Rs. 1,000/-, Chemistry laboratory - Rs. 3,000/-, and Biology laboratory - Rs. 2,000/-, per year, as Recurring Grants, for those Institutions, which have one Section of each class - IX, X and XI.

If the number of the Science students is more than 100, then an additional grant of Rs. 200/-, for each additional 50 students should be granted for each type of laboratory. The number of students includes the students of IX, X and XI classes.

(B). Specific Requirements to be fulfilled by each type of Laboratory -

Physics Laboratory -

I am giving below, a list of the main apparatus for the Physics laboratory. This list is prepared in accordance with the Practical course prescribed by the Board of Secondary Education of the Madhya Pradesh. This list of apparatus is sufficient, for an Institution, having one section, each of 36 students in IX, X and XI classes. If the Sections in these classes, are more, then, the Institutions must have more sets of the apparatus.

In this list, I have not given things of common use as the test tubes, beakers, jars etc. These articles may be purchased according to the needs of the students.

(A). General Apparatus -

S.No.	Quantity required.	Description of the articles required.
1.	2.	3.
1.	12	Retort stands.
2.	2	Cork borers set.
3.	1	Fortins barometer.
4.	12	Tripod stands.
5.	12	Burettes.
6.	12	Pipettes.
7.	12	U-Tubes.
8.	12	Hairs' Apparatus.
9.	6	Physical balances.
10.	6	Pestle and mortar.

(A). General Apparatus.(Contd.).

S.No.	Quantity required.	Description of the articles required.
1.	2.	3.
11.	3	Stop watches.
12.	2	Spirit level.
13.	5	Screw gauges.
14.	5	Slide callipers.
15.	2	Simple pendulum.
16.	1	Young Modulus apparatus.
17.	6	Hydrometers with glass jars.
18.	6	Specific gravity bottles.
19.	1	Parallelogram of forces apparatus.
20.	1	Boyle's Law Apparatus.
21.	3	Spherometers.
22.	2	Bucket and cylinder apparatus

(B). Heat -

1.	12	Centigrade thermometers -10° to 110°.
2.	12	Farenheit thermometers -10° to 220°.
3.	1	Maximum and minimum thermometer
4.	1	Regnault Hygrometer.
5.	2	Steam boilers copper.
6.	1	Bar and Gauge apparatus.

(b). Heat - (Contd.).

S.No.	Quantity required.	Description of the articles required.
1.	2.	3.
7.	1	Ball and ring apparatus.
8.	1	Conductivity apparatus.
9.	3	Coefficient of linear apparatus.
10.	1	Newton's Law of Cooling apparatus.
11.	1	Specific heat apparatus.
12.	1	Latent heat apparatus.

(C). Light -

1.	36	Plain mirror strips (7.5" x 2.5").
2.	12	Concave mirrors.
3.	12	Convex mirrors.
4.	6	Double concave lens.
5.	6	Double convex lens.
6.	12	Rectangular glass blocks.
7.	12	Glass prisms.
8.	1	Optical bench.
9.	1	Microscope.

(D). Magnetism -

1.	12	Bar magnets.
2.	1	Horse shoe magnet.

(D). Magnetism - (Contd.) -

S.No.	Quantity required.	Description of the articles required.
3.	1	Depleotion Magnetometer.
4.	24	Compasses.
5.	1	Dip. Circle.

(E). Electricity -

1.	2	Electrophorous.
2.	5	Electroscopes.
3.	6	Glass rods.
4.	6	Ebonite rods.
5.	6	Leclancho cells.
6.	3	Daniell cells.
7.	6	Accumulators 2-Volt, 40 amp. - hours.
8.	4	Galvanometers.
9.	4	Ammeters.
10.	6	Resistance coils.
11.	6	Rheostats.
12.	1	Meter bridge.
13.	1.	Potentiometer.
14.	12.	Press keys.
15.	2.	Electric bells.
16.	2.	Tangent Galvanometers.

(F). Sound -

S.No.	Quantity required.	Description of the articles required.
1.	1	Sonometer.
2.	12	Tuning forks.
3.	1	Kundt's tube apparatus.
4.	2	Resonance tube apparatus.

(G). Workshop apparatus -

1.	1 set of	Files, triangular, flat, and round.
2.	12	Hammers of different sizes.
3.	6	Pliers.
4.	12	Saws.
5.	12	Screw drivers.
6.	2	Soldering apparatus.
7.	2	Vices.
8.	2	Braces.
9.	1	Chisel.
10.	2	Drills.
11.	2	Glass cutters.

Chemistry Laboratory -

1.	4	Chemical balances.
2.	36	Pipettes.
3.	36	Burettes with stands.

Chemistry Laboratory (Contd.) -

S.No.	Quantity required.	Description of the articles required.
4.	36	Tripod stands.
5.	36	Retort stands.
6.	4	Mortars and pestles.
7.	36	Crucible tongs.
8.	2	Leibig's condensers.
9.	5	Dessicators.
10.	2	Water baths.
11.	6	Woulff's bottles.
12.	12 dozen.	Reagent bottles 8 ozs. on each shelf.
13.	36	Platinum wires for flame test.
14.	36	Bunsen burner or spirit lamp one on each seat.
15.	4	Kipp's apparatus.

All kinds of salts as prescribed for the identification in the Syllabus.

All kinds of acids and chemicals required for these identification.

In addition to the above materials, this laboratory must have the sink arrangement at each seat. It must have proper and sufficient number of Practical Tables with shelves fitted for the reagent bottles.

Test tubes, beakers, flasks, filter papers, funnels, crucibles, watch glasses, wire gauzes etc., should be purchased according to the requirements. It is better to issue a set of complete apparatus to each

student permanently. Thus, he will be responsible for the breakages of the articles, if any. This procedure, should be adopted for the XI class students only, as they have to do more of the practical work.

This laboratory should also have a sufficient quantity of kerosene oil, spirit, soaps, towels, matchboxes etc.

Biology Laboratory -

S.No.	Quantity required.	Descriptions of articles required.
1.	2.	3.
1.	6	Students' Microscopes.
2.	1 gross.	Microscope slides.
3.	12	Tripod magnifiers.
4.	12 sets.	Dissecting instruments.
5.	30	Dissecting boards.
6.	50	Specimen bottles.
7.	1	Microprojector.
8.	5	Collecting boxes.

In addition to the above apparatus, the Institutions should have one Aquarium and a Froggery. A Botanical Garden should also be attached to this laboratory. Moreover, there should be one Herbarium containing dry leaves, plants, roots, flowers etc., which are included in the Syllabus. This laboratory should also have specimens of insects and dead bodies of the animals required for the detailed study. It should also have skeletons of the animals included in the Syllabus.

(2). Recurring and Non-Recurring Expenses for these Science Laboratories -

In the following Pragraphs, the costs of the Physics, Chemistry and Biology Laboratories are given.

These costs include both the Recurring and the Non-Recurring expenses. This estimate is for the three sections - (IX, X and XI classes), each containing 36 students. If there are more sections, then the Non-Recurring Grant remains the same, but Recurring Grant should increase in proportion to the number of Sections. For each 50 additional students, an additional grant of Rs. 200/- should be sanctioned for each type of the laboratory.

A Recognition for the teaching of Science should be granted only to those Institutions which fulfil these conditions, about the Recurring Grants.

On the following page, is shown, in a Tabular form, the Recurring and Non-Recurring Grants for the Science Laboratory.

(P.T.O.).

TABLE NO. IV.

Recurring and Non-Recurring Grants for the Science Laboratory -

(I). Cost of Physics Laboratory :

(A). Laboratory Furniture -

S.No.	Items.	Cost. Rs.	Total expenses. Rs.
1.	2.	3.	4.
1.	Demonstration table--- 1.	300/-	
2.	Practical tables. --- 6.	1200/-	
3.	Stools for students.--36.	360/-	
4.	Teacher's chair. -- 1.	40/-	
5.	Almirahs. --- 6.	1500/-	
		Total. -- Rs.3400/-	Rs. 3400/-

(B). Laboratory Fittings -

1.	Water taps and sinks.	300/-	
2.	Electric fittings.	200/-	
3.	Gas burners.	200/-	
		Total.-- Rs. 700/-	Rs. 700/-

(C). Apparatus -

1.	Cost of all the apparatus given in the list of apparatus for the Physics laboratory.	Rs. 500/-	Rs. 500/-

(D). Chemicals, Acids and Salts -	Rs. 500/-	Rs. 500/-
(E). Miscellaneous Expenses. -	Rs. 400/-	Rs. 400/-
Grand Total.		Rs.10,000/-

Total Non-Recurring Expenses. ------- = Rs. 9,000/-
Total Recurring Expenses. ------ = Rs. 1,000/-
Total-- = Rs.10,000/-.

(II). Cost of Chemistry Laboratory :

(A). Laboratory Futniture -

S.No.	Items.	Cost.	Total expenses.
1.	2.	3.	4.
		Rs.	Rs.
1.	Demonstration table. --- 1.	300/-	
2.	Practical tables. --- 6.	1500/-	
3.	Stools for students. ---36.	360/-	
4.	Teacher's chair. ---01.	40/-	
5.	Almirahs. --- 6.	1500/-	
		Total. Rs.3700/-	Rs. 3700/-

(B). Laboratory Fittings -

1. Water taps and sinks.	500/-	
2. Electric fittings.	200/-	
3. Gas burners.	300/-	
	Total.Rs. 1000/-	Rs. 1000/-

(C). Cost of Apparatus required in the Chemistry Laboratory -	Rs. 2000/-	Rs. 2000/-
(D). Chemicals, acids and salts -	Rs. 2500/-	Rs. 2500/-
(E). Miscellaneous Expenses -	Rs. 800/-	Rs. 800/-

Grand Total. Rs. 10,000/-

Total Non-Recurring Expenses. ----- Rs. 7,000/-

Total Recurring Expenses. ---- Rs. 3,000/-

Total. --- Rs. 10,000/-

(III). Cost of Biology Laboratory.

(A). Laboratory Furniture -

S.No.	Items.	Cost.	Total Expenses.
1.	2.	3.	4.
		Rs.	Rs.
1.	Demonstration table. --- 1.	300/-	
2.	Practical tables. --- 6.	1200/-	
3.	Stools for students. ---36.	360/-	
4.	Teacher's chair. --- 1.	40/-	
5.	Almirahs. --- 6.	1500/-	
		Total. Rs. 3400/-	Rs. 3400/-

(B). Laboratory Fittings -

1. Water taps and sinks.	500/-	
2. Electric fittings.	200/-	
3. Gas burners.	300/-	
	Total. Rs. 1000/-	Rs. 1000/-

(C). Botanical Garden -	5000/-	5000/-
(D). Froggery -	4000/-	4000/-
(E). Apparatus for Biology Laboratory -	6000/-	6000/-
(F). Chemicals, acids and salts -	500/-	500/-
(G). Miscellaneous Expenses -	100/-	100/-

Grand Total. --- Rs.20,000/-

Total Non-Recurring Expenses . ------ Rs. 18,000/-
Total Recurring Expenses. ------ Rs. 2,000/-

Total. --- Rs. 20,000/-

(3). The necessity of Special Type of Training Courses for the Science Teachers in the Training Colleges -

At present, the Science Teachers get the same type of training courses in the Training Colleges as the other Teachers get. But, there is difference in the nature of the work of the Science Teachers. Science teachers require the general type of training but theyneed something more for their work. In the last Seminar of the Principals of the Post Graduate Basic Training Colleges of the Madhya Pradesh, this fact was given much importance. Now people have begun to realise this fact that the Science teachers should be trained in the laboratory organisation and management also.

The Training of the Science Teachers should include, besides the General Training, the following aspects :-

(i). Science Teachers must be trained as 'How to Plan a new laboratory for their Institutions'.

(ii). They must be taught the methods of organisation and management of the Science Laboratories.

(iii). They should know how to Plan the Practical work for the Science students.

(iv). They should be given the detailed knowledge about the laboratory fittings and laboratory furniture.

(v). They should be taught how to organise the Science Clubs, The Science Museums and the Science Exhibitions.

(vi). They must also get some practical training for the repairing of galvanometers, ammeters, charging of accumulators etc. These

repairs are very common in the Science Laboratories and the Science teachers are expected to do these repairs' work for keeping the instruments in the working order.

(vii). They must be trained to use Photographic Camera, Epidiascope, Cinema Projector, Tape-recorder etc.

Now a days, these instruments are very common in the Science laboratories of the advanced countries and their importance is being realised in India also.

All the above seven aspects of the Special Training Courses for the Science Teachers can be managed, if special arrangements are made in the Training Colleges.

I want to impress one more fact that generally the Training Colleges do not have the well-equipped Science Laboratories. The Training Colleges should have the Ideal Science Laboratories, because this is the only place where the Science Teachers get the real opportunity to know more about these laboratories. More attention should, therefore, be given to these Science Laboratories in the Training Colleges also.

Seventh Chapter

CHAPTER VII.

Outlines -

(I). Science Curriculum.

(II). Methods for Teaching Science.

(III). Teaching Aids.

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CHAPTER VII.

(I). Science Curriculum -

There are two types of courses in the Science subject in the Higher Secondary classes, according to the New Scheme. One is the course in the General Science which is compulsory for all the students i.e., the Science students and the Non-Science students, and the other is the Elective Science in the diversified group. This includes three subjects - Physics, Chemistry, and Biology or Mathematics. Only those students learn this subject who offer Science Group from the diversified group.

All the Science Teachers have expressed the view that the General Science should not be taught to the Science students as they get detailed knowledge of the same topics in the diversified group. Thus, the work is duplicated practically with no use. This time can be saved and it can be devoted to other important subject. Thus the General Science should be taught to the Non-Science students only.

The present Syllabus of the General Science is not satisfactory. I have come to know that only two periods per week are devoted for the teaching of the General Science. The Syllabus in the General Science includes the topics from Physics, Chemistry, Biology, Mathematics, Statistics etc. Thus the course of this subject is very bulky and it cannot be finished with the little time devoted to it. Hence this Syllabus should be revised and should be reduced. Moreover, the present Syllabus of the General Science is more theoretical and out of date. No Demonstration work and Practical work are done in this subject. It is a new subject for the Non-Science student, hence the teaching of

the General Science should be made very interesting. Unimportant topics should be replaced by useful and modern knowledge. The Syllabus in this subject should be regarding the Problems of the daily life of the students.

History of the Scientific Inventions and Life Histories of the Scientists should be taught to the students. A good knowledge of the Modern Inventions should be given to them. They should learn about the Air, Water, Heat, Food etc. They should be given a proper knowledge of Hygiene. They should also know the working of the common machines of the daily use as Bicycle, Primus Stove, Fountain-pen, Electric bell, Matches, Photographic Camera etc. They should also have a useful knowledge of the Electricity. They should even study the common plants, flowers, birds, insects, rocks and soils. They should learn how to make soaps, matchboxes, hair-oils, pen-ink etc. In short, only that knowledge should be given to the students which is useful in their daily life. At present old and unimportant topics are included in the Syllabus of the General Science.

The other defect is that the Higher Secondary students do not have external examination in this subject. Only a formal internal examination is taken in XI class and marks are sent to the Board. Thus the students and even teachers do not take care to complete the course in this subject. Thus the teaching of this subject becomes defective. Hence, I propose that there should be external examination in this subject also like the other subjects. Only then, the students will learn this subject seriously and thoroughly.

The next difficulty is about a teacher who can teach all the topics included in the Syllabus of the General Science. At present, one

single teacher cannot teach all the topics, which are included in the Syllabus of General Science. If one can teach Physics, Chemistry and Mathematics, then he is unable to teach Biological topics. A Biology teacher is unable to teach Mathematical topics. The best way is to make such arrangements in the Time-table that the different topics of General Science could be taught by the teacher of particular subject only.

Elective Science subject includes - Physics, Chemistry, Biology or Mathematics. Syllabuses in these subjects are also defective. About 2/3rd courses of this subject are to be covered in XI class and very elementary courses are prescribed in X class. In XI class students are to appear for external examination in Practical work. Thus after December, no teaching work is possible. The students therefore get less time in XI class. Thus in ~~IX or~~ XI class... - Revision of IX and X class courses is not possible under these circumstances. Even the course of XI class is completed very hurriedly. This procedure is very defective. Thus there is no even distribution of courses in IX, X and XI classes. A better procedure is to complete 70 % course in IX and X classes. Only 30 % course ~~she~~ should be left for XI class and the rest of the time in XI class should be devoted for the Revision work of all the three classes. The present IX class course in these subjects is of very elementary nature. Most of the topics in IX class are mere repetition of VIII class work. There should be a natural link between the courses of the different classes.

More attention is paid towards the theoretical teaching and students with all that has been taught to them remain as unscientific, as they were, when they started their studies. The topics are repeated in the Higher Secondary classes and there is no link in the courses of

IX, X and XI classes. The present Syllabuses in these subjects are bookish, narrow and away from the modern development in the Scientific knowledge. These courses are stereotyped and away from the Problems of their daily life. Science courses in the Secondary School curriculum should respond to the development of the New Knowledge in Science. The Syllabus should be arranged in a logical order. More attention should be given to the Problems of Food, Water, Health, Recreation, Control of diseases etc. In IX class difficult numerical calculations should be avoided. A Committee of experienced Higher Secondary Science Teachers should be appointed to Re-view and to frame the New useful Syllabus in these subjects. The present Syllabuses are framed by the Degree College Teachers who do not have knowledge about the mental condition of the Higher Secondary students. Only the Higher Secondary teachers know their students well and can realise their difficulties well. Hence only they can frame proper, justified and useful Syllabuses for these subjects, for them. Thus the Higher Secondary Teachers should have important places in the Committees to prepare the Curriculum for the Higher Secondary classes.

(II). Methods of Teaching Science subjects -

At present, 80 % Science lecturers in the Higher Secondary schools are Fresh M.Scs., from the University. They have no knowledge about the needs, interests, and methods of teaching for the Higher Secondary students These teachers do not have any type of training and they use mostly the Lecture Methods, which is usually more common a system in the Degree classes. Now, this Lecture Method is not at all useful for the Higher Secondary students. What they need is a special method of teaching. Thus

the first important point is that all the Higher Secondary teachers should be trained without exception. They should have B.T.* or B.Ed. Degrees before their appointments in the Higher Secondary Schools. The present un-trained Lecturers should be sent for the Training. The old Trained Teachers should be given the Refresher Courses in the Training Colleges.

The Methods usually adopted in the Teaching of the Science subjects to the Higher Secondary students are as shown below :-

(1). Demonstration and Laboratory Methods.
(2). The Heuristic Method.
(3). The Inductive and Deductive Methods.
(4). The Historical Method.

The Method for Teaching a Scientific Topic depends on the Nature of the topic, hence a proper method for a particular topic should be selected. I want to make one thing clear that the usual Lecture Method is not suitable for the Higher Secondary students and hence its use should be limited in the class.

While Planning a lesson, a Science teacher should keep in view the following things to make the lesson interesting and instructive :-

(1). Science should be taught by a Scientific Method of collecting the Data and making experiments before arriving at the conclusions and stating the principles.

(2). He should start with what the pupils know and proceed to what they do not know.

(3). The new topic to be taught should be presented to the students in the form of a Problem to be solved by them.

(4). For learning to be effective, there must be continuity of thought. Disconnected items should not be presented before the students.

(5). The teacher should try to maintain the interest and the enthusiasm of the student-community in the class, with the help of the Teaching Aids, with occasional jokes and by putting interesting and instructive questions to them occasionally.

More importance should be given to the Demonstration work in the class room. The present tendency of the Science teachers is to minimise the Demonstration work, as it demands extra labour and preparations. But this tendency is wrong. The Science teaching cannot be effective without a Demonstration and laboratory work. That is why I have proposed that less periods must be given to the Science teachers so that they can arrange the apparatus for their Demonstrations or prepare their Illustrative Aids.

The Heuristic Method requires that the students should have their Scientific studies from the point of view of and in the Spirit of the Research-worker. The students are expected to discover by their own experiments with little or no suggestions from their teacher.

This method can be used for teaching some topics. The Historical Method can be used for introducing certain theoretical concepts as the 'Nature of the Heat', the 'Ionic Theory of the Electrolytes' etc.

Students should be encouraged to use the Library books more and more. Class discussions also produce very useful results in making the

concepts of the students clear. The Science teachers should not dictate Notes to the students in their classes. The students should be asked to prepare their own Notes. Sufficient and Regular Written Home work should be allotted to the students.

Teaching Aids -

The Importance of the various Teaching Aids is greater in the Science lessons than in any other subject. The Teaching Aids make the Science lessons more interesting and they make the ideas more vivid and clear. Many complicated machines can be explained easily to the students, with the help of these Teaching Aids. More Teaching Aids should be used in their Science lessons.

There are many kinds of these Teaching Aids which can be used in the Science lessons. I am describing here some common Teaching Aids which are used in the Higher Secondary Schools usually :-

(1). The most effective teaching aid is the handling of the apparatus and materials by the students themselves. Hence, more attention should be paid to the Practical and Demonstration work.

(2). A proper use of the Black Boards and Coloured Chalks can also make the Science Lessons interesting and easier.

(3). Pictorial Aids as Pictures, Diagrams, Drawings, Photographs, Charts etc., can also be used in the Science lessons with a great advantage. Many difficult ideas and complicated problems can also be made easier with these Aids.

(4). Models of costly apparatus can make the learning real. Models of

Steam Engine, Electric Dynamos, Electric Motors etc., are very common.

(5). Epidiascope is very useful in Science lessons as it can project and magnify a small horizontal diagrams on the screen. Hence, minute details are made clearer with its help and the whole class can see the aid at the same time.

(6). Tape-recorder, Radio and Cinema Projectors are also some of the costly teaching aids. They are much used in the advanced countries. In India a few Higher Secondary Schools only can afford to have these teaching aids. But these Teaching Aids are very helpful in the Science lessons.

The Science Teacher should be very resourceful in selecting the Teaching Aids for his lessons. Charts and Diagrams prepared by the students are more Educative than the Ready-made Charts. The students should be encouraged to prepare the Charts and Diagrams themselves.

****

Appendixes

APPENDIX 'A'.

List of the persons Interviewed -

S.No.	Name.	Designation and address.
1.	2.	3.
1.	Shri M.B. Lalge.	Principal, Maharajwada Higher Secondary School, Ujjain. M.P.
2.	Shri Shrivallabh Nagar.	Principal, Malhar Ashram Higher Secondary School, Indore. M.P.
3.	Shri Sewaram Chaturvedi.	Principal, Boys' Higher Secondary School, Bhopal. M.P.
4.	Shri Chatterjee.	Principal, Mahatma Gandhi Higher Secondary School, Javra. M.P.
5.	Miss Kelkar.	Principal, Kamla Nehru Girls' Higher Secondary School, Jaora. M.P.
6.	Shrimati Padmanabham.	Principal, Bal Vinaya Mandir, Indore. M.P.
7.	Shri V.A. Buddhiwant.	Science Lecturer, Government Higher Secondary School, Agar. M.P.
8.	Shri Dube.	Biology Lecturer, Maharaj Wada Higher Secondary School, Ujjain. M.P.
9.	Shri Kailash Chandra Chaturvedi.	Science Lecturer, Maharajwada Higher Secondary School, Ujjain. M.P.
10.	Shri Baldeo Singh Varma.	Science Lecturer, Malhar Ashram, Indore. (M.P.).
11.	Shri K.C. Tandon.	Science Lecturer, Higher Secondary School, Khachrod, M.P.
12.	Shri N.B. Nabhar.	Science Lecturer, Higher Secondary School, Bareli. M.P.
13.	Miss Indumati Pandit.	Junior Professor, Girls' Degree College, Indore. M.P.
14.	Shri V.K. Jaddhari.	Biology Lecturer, Boys' Higher ~~Secondary~~ Secondary School, Neemuch M.P.

Appendix 'A' (Contd.) -

List of the persons Interviewed -

S.No.	Name.	Designation and address.
1.	2.	3.
15.	Shri S.B. Borgaonkar.	Science Lecturer, Higher Secondary School, Maheshwar. M.P.
16.	Shri S.G. Deshpande.	Science Lecturer, Government Higher Secondary School. Mhow. M.P.
17.	Shri Raghunath Prasad Shrivastava.	Science Lecturer, Gorkhi Higher Secondary School, Lashkar. M.P.
18.	Shri Nandkishore Sharma.	Science Lecturer, Higher Secondary School, Namli. M.P.
19.	Shri K.N. Singh Bhalla.	Science Lecturer, Maherajwada, Ujjain.M.P.
20.	Shri Salsankar.	Science Lecturer, Malhar Asharam, Indore. M.P.
21.	Miss Vargis.	Science Teacher, Kamla Nehru Girls' Higher Secondary School, Jaora. M.P.
22.	Shri S.C. Saxena.	Science Lecturer, Maharaj Wada, Ujjain.M.P.
23.	Shri V.G. Phadke.	Principal, Shri Ganesh Vidya Mandir, Indore. M.P.
24.	Shri N.C. Chaudhry.	Science Lecturer, Nutan Higher Secondary School, Indore. M.P.
25.	Shri G.S. Nandedkar.	Science Teacher, Girls' Higher Secondary School, Ujjain. M.P.
26.	Shri S.M. Rawat.	Biology Lecturer, M.G. Higher Secondary School, Jaora. M.P.
27.	Shri Nahar.	Science Lecturer, Kamla Nehru Girls' Higher Secondary School, Jaora. M.P.
28.	Shri Narendra Nath Gupta.	Biology Lecturer, Government Higher Secondary School, Sabalgarh (Morena). M.P.
29.	Shri Maudan Trivedi.	Biology Lecturer, Malhar Ashram, Indore.M.P
30.	Shri Anand Mohan Saxena.	Science Teacher, Higher Secondary School, Khachrod. M.P.

APPENDIX 'B'.

List of the Laboratories visited -

S.No.	Name of the Institution.
1.	Maharajwada Higher Secondary School, Ujjain. M.P.
2.	Sarafa Girls' Higher Secondary School, Ujjain. M.P.
3.	Jal Higher Secondary School, Ujjain. M.P.
4.	Mahatma Gandhi Higher Secondary School, Jaora. M.P.
5.	Kamla Nehru Girls' Higher Secondary School, Jaora. M.P.
6.	Malhar Ashram Higher Secondary School, Indore. M.P.
7.	Bal Vinaya Mandir Higher Secondary School, Indore. M.P.
8.	Canadian Mission Girls' Higher Secondary School, Indore. M.P.
9.	M.S. Higher Secondary School, Indore. M.P.
10.	Tilokchand Jain Higher Secondary School, Indore. M.P.
11.	Cambridge School, Bhopal. M.P.
12.	Daly College, Indore. M.P.
13.	Khalsa Higher Secondary School, Indore. M.P.
14.	Government Higher Secondary School, Badnawar. M.P.
15.	Government Higher Secondary School, Tarana. M.P.
16.	Government Higher Secondary School, Khachrod. M.P.
17.	Narayan Vidya Mandir, Dewas. M.P.
18.	Higher Secondary School, Ratlam. M.P.
19.	Higher Secondary School, Nagda. M.P.
20.	Government Higher Secondary School, Sehore. M.P.

APPENDIX 'C'.

QUESTIONNAIRE PART 'A'.

(For Science Lecturers and Teachers).

Note : 1. Please strike off the portion from the given Yes/No answer against the questions with which you do not agree.

2. Please put tick mark and cross mark wherever required.

3. Write your opinion in the bracket against those questions wherever required.

****

I. Laboratories and their fittings -

(a). Do you have separate laboratories for Physics, Chemistry and Biology in your Institution ? --- Yes/No.

(b). Do you think that separate laboratories are necessary for Physics, Chemistry and Biology for Higher Secondary School ? --- Yes/No.

(c). Do you have the following arrangement in your laboratory ?

(i). Dark room. ( ).

(ii). Electric fitting. ( ).

(iii). Water taps. ( ).

(iv). Sinks with Practical tables. ( ).

(v). Gas Plant. ( ).

(d). What is the size of your laboratory room ?

Length ( ), Breadth ( ).

II. Laboratory Furniture -

(a). What is the size of the student practical table of your laboratory ?

Length ( ), breadth ( ), height ( ).

Appendix 'C(. (Contd.) -

II. Laboratory Furniture (Contd.) -

(b). How many students work on each practical table ? (   ).

(c). Do you have sufficient number of almirahs to store apparatus and chemicals ? Yes/No.

(d). Do you provide stools or chairs to students in the laboratory ? Yes/No.

III. Time devoted for Practical work -

(a). How many periods per week do you devote for the practical work for your subject ? (   ).

(b). What is the duration of each period ? (   ).

(c). How many periods per week are necessary for the practical work of your subject ? (   ).

IV. Laboratory Assistant and Peon -

What is the arrangement for laboratory assistant and peon for your laboratory in your institution ?

(Please put a tick mark against the statement you support).

(a). There are separate laboratory assistants for Physics, Chemistry and Biology Department. (   ).

(b). There is one common laboratory assistant for all the three Departments. (   ).

(c). There are separate laboratory peons for Physics, Chemistry and Biology Departments. (   ).

(d). There is one common peon for all the three Departments. (   ).

V. Number of periods for Science Lecturers and Teachers -

Appendix 'C' (Contd.) -

V. Number of periods for Science Lecturers and Teachers -

(a). How many Theory periods per week do you take ? (   ).

(b). How many Practical periods per week do you take ? (   ).

(c). How many Theory periods per week should be given to Science teacher so that the laboratory work may not suffer ?

(   ).

VI. Laboratory Records and Stock-checking -

(a). Do you maintain the following Registers for your Laboratory ?

(i). Stock Register for perishable articles. Yes/No.

(ii). Stock Register for non-perishable articles. Yes/No.

(iii). Issue Register. Yes/No.

(iv). Breakage Register. Yes/No.

(b). Do you charge some fine from students for breakages ? Yes/No.

(c). Do you check your stock once a year ? Yes/No.

VII. Recurring grant for laboratory -

(a). Please give number of Science students in your Institution -

(i). Physics. (IX). ______. (X). ______.(XI). ________.

(ii). Chemistry. (IX). ______. (X). ______. (XI). ________.

(iii). Biology. (IX). ______. (X). ______. (XI). ________.

(b). How much Recurring grant per year do you get for your laboratory ?

(i). Physics laboratory. --- Rs.

(ii). Chemistry laboratory.-- Rs.

(iii). Biology laboratory. -- Rs.

(c). Do you think that this recurring grant is sufficient for your laboratory ? Yes/No.

Appendix 'C' (Contd.) -

VII. Recurring grant for laboratory - (Contd.) -

(d). What minimum recurring grant should be given per year for your laboratory ?

(i). Physics laboratory ---- Rs.

(ii). Chemistry laboratory.--- Rs.

(iii). Biology laboratory. --- Rs.

VIII. Purchases for laboratory -

(a). Does your Principal consult you for the purchases of your Department ? Yes/No.

(b). Do you call quotations before making purchases ? Yes/No.

(c). Please give the addresses of reliable Firms from which you purchase apparatus and chemicals.

1.

2.

3.

IX. Other activities of Science laboratory -

(a). Do you have the following activities in your Institution ?

(i). Science Club. Yes/No.

(ii). Workshop. Yes/No.

(iii). Science Library. Yes/No.

(iv). Science Exhibition. Yes/No.

(v). Science Fairs. Yes/No.

(b). Do you give some marks for Annual Examination to those students who take active part in these activities ? Yes/No.

Appendix 'C'. (Contd.) -

X. Please give your valuable suggestions for improving the standard of Science Laboratories in Higher Secondary Schools of Madhya Pradesh -

1.

2.

3.

(P.T.O.).

(११ वीं कक्षा के विज्ञान के छात्रों के लिये)

विक्रम विश्व विद्यालय, उज्जैन (म. प्र.)

एम. एड. कक्षान्तर्गत आयोजित शोध कार्य

विषय.— विज्ञान प्रयोगशाला सम्बन्धी प्रश्नावली.

विद्यार्थी का नाम:—

विद्यालय का नाम:—

कक्षा:— विभाग:—

महोदय/, महोदया,

मैं विक्रम विश्व विद्यालय, उज्जैन की एम. एड. कक्षान्तर्गत "मध्यप्रदेश के उच्चतर विद्यालयों की विज्ञान प्रयोग शालाओं की वर्तमान स्थिति" पर शोध कार्य कर रहा हूँ। इस सम्बन्ध में तथ्य संकलित करने की दृष्टि से यह प्रश्नावली पूर्ति हेतु आपके पास भेज रहा हूँ। अतः आपसे अनुरोध है कि इस प्रश्नावली की पूर्ति कर शोध कार्य में सहयोग प्रदान करें। आशा है कि आप प्रश्नों का उत्तर निर्भीकता तथा सच्चाई के साथ देंगे। मैं आपको यह विश्वास दिलाता हूँ कि आपके उत्तरो को गोपनीय रखा जावेगा।

आपका विश्वास पात्र
उदयलाल चौधरी,
एम. एड, छात्र
पी. जी. बी. टी. कालेज, उज्जैन.

प्रश्नों के उत्तर भरने के लिये निर्देश.–

नीचे कुछ प्रश्न आपके विद्यालय की विज्ञान प्रयोग शाला की वर्तमान स्थिति जानने हेतु दिये गये हैं। प्रश्नों के उत्तर नीचे बतलाये अनुसार ही लिखिये:–

१. हां। नहीं उत्तर वाले प्रश्नो के उत्तर में जिससे आप सहमत नही हो उसे काट दें।

२. जहाँ अनेक उत्तर दिये गये हैं वहां आप अपने सहमति के उत्तर पर चिन्ह अंकित कर दें।

३. जिन प्रश्नो के सम्मुख उत्तर के लिये स्थान रखा गया है वहा आप अपना उत्तर स्वयं लिखे।

◆

खंड ब (११ वीं कक्षा के विज्ञान विषय के छात्रों के लिये)

१. आपने निम्न लिखित विषयो मे कक्षा नवी तथा दसवीं मे कितने प्रयोग किये हैं ? संख्या लिखिए।

(अ) कक्षा ९ वी – भौतिक शास्त्र ( ), रसायन शास्त्र ( ), बायलॉजी ( ).

(ब) कक्षा १० वी:– भौतिक शास्त्र ( ), रसायन शास्त्र ( ), बायलॉजी ( ).

२. आप निम्नलिखित विषयों में प्रयोग शाला में प्रयोग अकेले करते हैं अथवा ग्रुप में ?

(अ भौतिक शास्त्र:– (i) अकेले, (ii) दो के ग्रुप में, (iii) तीन या अधिक के ग्रुप में.

(ब) रसायन शास्त्र:– (i) अकेले, (ii) दो के ग्रुप में, (iii) तीन या अधिक के ग्रुप में.

(स बायलाजी;– (i) अकेले, (ii) दो के ग्रुप में, (iii) तीन या अधिक के ग्रुप में.

३. क्या आपकी प्रयोग शाला में प्रयोग करते समय चोट आने पर इलाज किया जाता है ? हां। नहीं

५. आपके विद्यालय में निम्नलिखित व्यवस्था है अथवा नहीं:-

(अ) विज्ञान पुस्तकालय हाँ । नहीं
(ब) विज्ञान क्लब हाँ । नहीं
(स) वर्क शाप हाँ । नहीं
(द) विज्ञान अजायब घर हाँ । नहीं

६. क्या आपके विद्यालय में विज्ञान-प्रदर्शनी का आयोजन किया जाता है ? हां । नहीं

७. पिछली विज्ञान प्रदर्शनी में आपने क्या क्या कार्य किया ?

(अ) प्रयोग किये उनकी संख्या लिखिये
(ब) मॉडल बनाये
(स) चार्ट बनाये

८. क्या आपको इन कार्यों के लिए कुछ अंक वार्षिक परीक्षा में दिये गये ? हां । नहीं

९. इन कार्यों के लिये धन किस प्रकार प्राप्त होता है ?
(अ) विद्यालय से (ब) स्वयम् से

१०. आपको अपने विद्यालय की प्रयोग शालाओं की व्यवस्था से किस प्रकार का सन्तोष है :—
(अ) भौतिक प्रयोग शाला:— पूर्ण सन्तोष, साधारण सन्तोष, सन्तोष नहीं है
(ब) रसायन प्रयोग शाला:— पूर्ण सन्तोष, साधारण सन्तोष, सन्तोष नहीं है
(स) बायलॉजी - प्रयोग शाला:— पूर्ण सन्तोष, साधारण सन्तोष, सन्तोष नहीं है

११. आपके प्रति प्रयोगशाला सहायक का व्यवहार कैसा है ?

(अ) अति उत्तम (ब) उत्तम, (स) साधारण, (द) असन्तोष जनक ।

१२ अपने विद्यालय की प्रयोग शाला के सुधार के लिये अपने सुझाव यहाँ लिखिये :—

दिनांक:—

विद्यार्थी के हस्ताक्षर

APPENDIX 'D'.

List of the Addresses of some Prominent Firms dealing in the Scientific Apparatus and Chemicals.

S.No.	Name and Address of the Firm.
1.	M/S. Ondez Ltd., Mooli Street, Bombay 2.
2.	M/S. S. Mathuradas & Co., Princess Street, Bombay 2.
3.	M/S. Comet Chemicals, Bombay 2.
4.	M/S. Mars & Co., Bombay 2.
5.	M/S. British Drug House, Imperial Chemical Building, Bombay 1.
6.	M/S. Luthra Scientific Co., Delhi 6.
7.	M/S. National Scientific Apparatus Co., New Delhi.
8.	M/S. Allied Scientific Corporation, Jawahar Nagar, Delhi 6.
9.	M/S. Oriental Scientific Apparatus, Ambala Cantt.
10.	M/S. Herinder Scientific Works, Opposite Jain Temple, Ambala Cantt.
11.	M/S. Dholpur Glass Corporation, Private Ltd., Dholpur.
12.	M/S. Hargolal & Sons, Ambala Cantt.
13.	M/S. Globe Trading Co., Poona 4.
14.	M/S. Scientific Instrument Co., May Pole, Madras.
15.	M/S. The India Scientific Instrument Factory, Jabalpur. M.P.
16.	M/S. Scientific Suppliers Corporation, Noori Gate Road, Agra. U.P.
17.	M/S. Educational Traders, Nai Ki Mandi, Agra. U.P.
18.	M/S. The Andhra Scientific Co. Masulipattam. (S.India).
19.	M/S. Peaky Scientific Industries, Ramkrishana Nagar, Kanpur. U.P.
20.	M/S. The Ganga Glass Works Private Ltd., Bala Waly, District Bijnor. U.P.

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